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J. F. KELLY, Editor

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COMING MEETINGS ...AND PAPERS...

CLEVELAND SECTION

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"ELECTRIC OVERHEAD TRAVELING CRANES"

FRIDAY, FEBRUARY 28, 1930

"THE USE OF VACUUM TUBES IN INDUSTRY"

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ELECTRIC POWER CLUB — CHICAGO, ILL.

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N. C. BYE, Chairman — L. O. MORROW, Secretary

SATURDAY, JANUARY 4, 1930

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THE MANUFACTURE OF CAST IRON PIPE"
by
GEO. PFEFFER, Chief Electrician, Florence Pipe Foundry and Machine Co., Florence, N. J.

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ALL DAY SESSION

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By H. V. FLAGG, Comb. Engr., American Rolling Mill Co., Middletown, Ohio

"THE SUBJECT OF NITRIDING"
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"COMPARATIVE METHODS OF FLOW INSTRUMENTS IN CONNECTION WITH COKE OVEN GAS"
By J. M. SPITZGLASS, Republic Flow Meters Co., Chicago, Ill.

"GROUP VS. INDIVIDUAL DRIVEN ROLLING MILL STANDS"

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EDITORIAL

THE NEW SUPERINTENDENT OF WELDING

In a number of Iron and Steel Plants, the progressive executives have established Welding Departments, whose present functions are to salvage the many pieces of apparatus and machinery which formerly were sent to the melting pot, to be used as a part of the scrap which goes to make up the charge for the Open Hearth, etc.

Under the old system (which is still part of many Steel Plants Practice), hundreds of thousands of dollars worth of machinery and apparatus found their way to the scrap pile which could have been salvaged, provided a competent welding overseer could have had an opportunity to recover it.

The modern plant today has a welding superintendent who decides whether a broken or worn piece of machinery may be recovered by either the Thermit, Fusion Arc or Oxy Acetylene Process. All of these processes and methods have their respective fields and great savings may be effected by using the correct method.

It has also been demonstrated that it is not necessary to carry as large an inventory of spare parts with the establishment of the centralized welding department.

A number of steel plants with centralized welding departments have shown a savings of as much as a quarter of a million dollars in one year's operation.

Every Steel Plant should investigate the possibilities of a centralized welding department, no apparatus, no machinery, should be allowed to reach the scrap pile until it has passed through the centralized welding department and a competent welding superintendent has passed his opinion upon it.

In reaching about in the plant for a means to economize the executives of the Iron and Steel Plants can find no agent which will produce results in dollars and cents as quickly as a centralized Welding Department.

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10" Strip Mill American Steel and Wire Company

By F. A. SNYDER† and R. H. WRIGHT*

The last few years have witnessed a considerable change in the status of continuous and semi-continuous mills. At one time the continuous mill was considered economical only for rolling large tonnages of a few sections with infrequent change of section. Modern continuous and semi-continuous mills with individual adjustable speed motor drives have proved to be so flexible that they are not only used for rolling a wide range of products but have become formidable competitors of the small jobbing merchant mill in many lines. Many of the more recent tandem mills have been designed to roll comparatively heavy material at moderate speeds and the tandem stands have not been mounted on close centers. The American Steel and Wire Company have had in successful operation for over a year at the Cuyahoga Works a 10" semi-continuous strip mill which rolls very light sections at high speed. This mill has a tandem finishing train of five individually driven stands mounted on seven foot centers. Metal is delivered from the last finishing stand at speeds up to 2700 feet per minute. When the mill is set for the maximum speed the front end of a finished piece leaves the mill 1¼ seconds after the bar enters the first stand of the finishing train. The construction of a mill to operate under these conditions involved considerable pioneer work and made it desirable to employ electric drives having considerable refinement of control in order to provide the best possible operating conditions.

Figure 1 above, gives general view of mill, looking toward the heating furnace, which can be seen in the background. Immediately in front of the furnace is a billet shear followed by four tandem roughing stands, driven by a 750 hp., 200/600 rpm. d.c. motor. Directly in line with the roughing stands there are four intermediate stands and a vertical edger. The intermediate stands are driven by a 1200 hp., 125/275 rpm. d.c. motor. A 150 hp., 300/900 rpm. d.c. motor drives the vertical edger through a gear unit. After leaving the last intermediate stand

†Elec. Engr., American Steel & Wire Co., Cleveland, O.
*Steel Mill Engr., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

FIG. 2.

the bar passes through a mechanical looper into a horizontal edging stand driven by a 150 hp., 300/750 rpm. d.c. motor. From the horizontal edger the metal passes through a second mechanical looper into the first of the five tandem finishing stands. Each finishing stand is direct connected to a 500 hp. adjustable speed d.c. motor; the speeds ranging from 250/380 rpm. on the first stand to 667/1000 rpm. on the last stand.

The finished material is turned on edge and passes to either one of two vibrator rolls which throws the metal in serpentine form on a slowly moving conveyor. The cooled strip is then coiled in vertical spindle reels and drawn by chain conveyors to special trucks which are hauled away by tractors. Figure 2 gives a view of the finishing end of the mill.

Power for the mill is supplied at 13,200 volts, 3

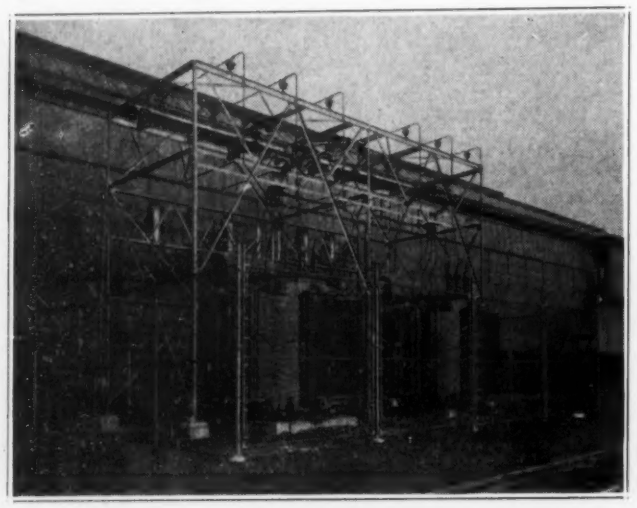


FIG. 3.

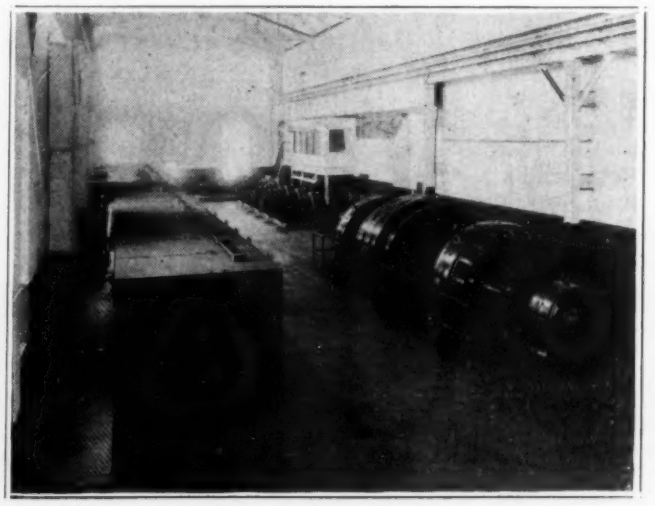


FIG. 4.

phase, 25 cycles over two underground lines which are connected to the American Steel and Wire power system. The underground lines terminate at the Cuyahoga Works in an outdoor transformer substation, shown in Figure 3. This substation con-

FIG. 5.

sists of two 5000 kva., 13,200/6600 volt, 3 phase, step down transformers and the necessary gang operated disconnecting switches for changing connections in the high voltage or low voltage circuits. All switching under load in the 13,200 volt circuits is done at the power house end of the underground lines.

The 6600 volt lines from the transformers are brought into a truck type switching structure shown in the left foreground of Figure 4. In this structure

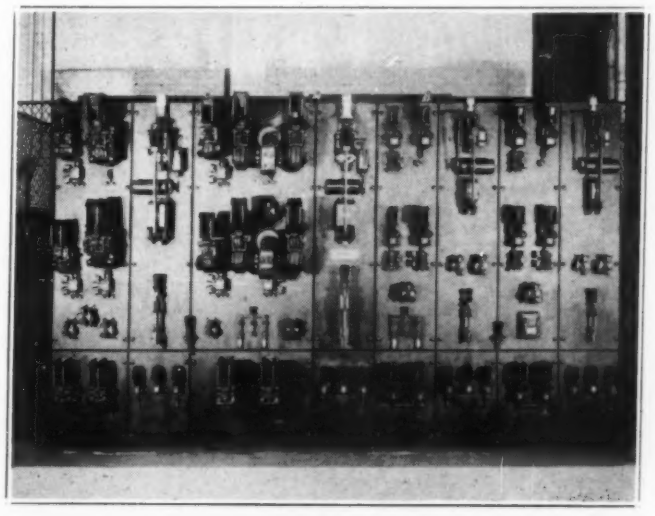


FIG. 6.

are located the truck type oil circuit breakers and the instrument transformers for two incoming lines, two 6600 volt feeder circuits, a 4000 kw. motor generator and a 300 kw. motor generator.

All the main motors are wound for 600 volts d.c. and receive power from a 4000 kw. (6000 kw., 2 hours) 600 volt, 3 unit, 500 rpm., 80% power factor synchronous motor generator, shown in the right

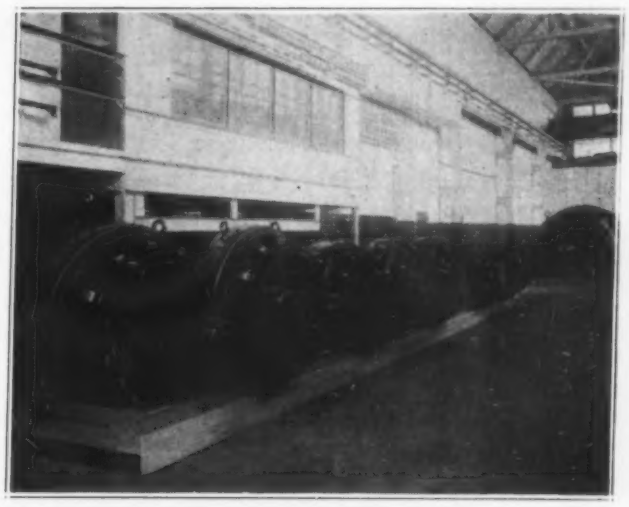


FIG. 7.

foreground of Figure 4. A 120 kw., 250 volt direct connected generator supplies excitation to the motor generator and the 600 volt motors. A 300 kw., 750

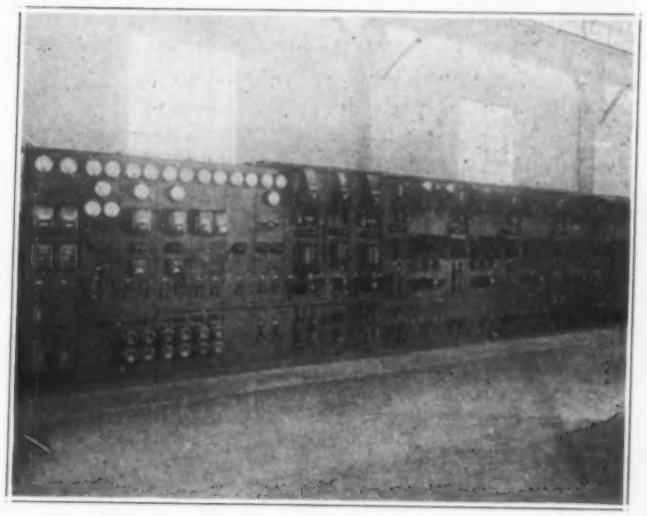


FIG. 8.

rpm., 80% power factor synchronous motor generator furnishes power to the 230 volt mill auxiliaries. The a.c. and d.c. control panels for the motor generators

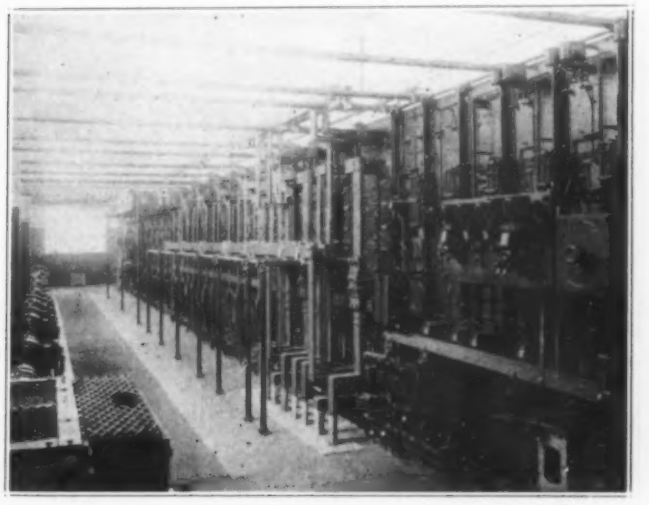


FIG. 9.

together with the control panels for the 5 finishing train motors, is shown in Figure 8.

The 1200 hp., 750 hp. and 2 150 hp. motors for the roughing, intermediate and edging stands are located in a separate motor house which can be seen at the right of Figure 1. Figure 5 is an interior view of this motor house. Each motor is controlled by a magnetic starter with grid type starting resistor. A front view of the control panels is shown in Figure 6. Speed adjustment is obtained by means of motor operated field rheostats located in the basement. The four motors in this room are equipped with series exciters and the inherent speed regulation at any point in the speed range does not exceed 2½%. Due to the comparatively slow speed of the steel in this part of the mill extremely fine speed regulation is not required.

The five 500 hp. motors for the finishing train are located in the main substation. They are mounted on a common bedplate with shafts on 7 foot centers. Figure 7 gives an installed view of the motors and shows the location of the mill pulpit just above the motors. A magnetic starter, included as part of the substation switchboard (Figure 8) is provided for each motor.

Foundations and buildings were laid out to give ample clearance and head room around the electrical equipment and to provide space for the dissipation of the heat from the machines. Both the main substation and the roughing and intermediate mill motor house are supplied with filtered air under pressure. The switchboard and control panels have been arranged so that the wiring, bus work, resistors and rheostats are easily accessible. Figure 9 is a rear view of the main switchboard and illustrates the type of construction employed.

The finishing train is designed for higher delivery speeds than any previous mill having individually driven stands mounted on close centers and little practical data was available to serve as a guide in determining exactly how the speed regulation of the motors would affect the operation of the mill. It was therefore felt that the finishing mill motors and the small motors driving the vibrators should be equipped with speed regulators of the most accurate type. Previous experience had demonstrated the high sensitivity and accuracy of the synchronous vibrating regulator and this type of regulating equipment was chosen.

The scheme employed is that of matching frequencies through the medium of an electro-mechanical differential. A master frequency set supplies low voltage alternating current at constant frequency to each speed regulating panel. The speed of the master frequency set can be varied 7½% above or below the normal operating frequency to permit adjustment of the entire group of mill motors as a whole. A pilot generator is connected to each mill motor by means of a variable ratio drive. A regulator panel is provided for each motor, having at the top two small synchronous motors driving into opposite sides of a set of differential gears. One synchronous motor is connected electrically to the master frequency set and the other to the pilot generator of the motor which is regulated by that panel.

When the motor under regulation is exactly in synchronism with the master frequency generator the synchronous motors on the regulator rotate at the same speed and the central member of the differential is stationary. The slightest change in the speed or even in the angular position of a point on the circumference of the armature of the motor under regulation imparts a movement to the central member of the differential. This movement is transmitted through a mechanical linkage to the arm of a vibrating regulator which actuates vibrating contacts controlling the field current of the mill motor. The vibrating contacts can vary the field current over wide limits to bring the motor armature back into correct speed and phase relation very quickly. With this system of control a group of motors are held in step as though each motor were a synchronous machine. There is no constant error or slip, but merely an angular displacement of the armature with load, as in a synchronous motor.

The pilot generators are driven by their respective motors through Reeves drives, and the speed of an individual motor is adjusted by changing the ratio of this drive by means of a motor operated speed changing device controlled from the mill pulpit. Careful stroboscopic tests and a year of actual service have shown that these drives can be adjusted with any desired degree of accuracy.

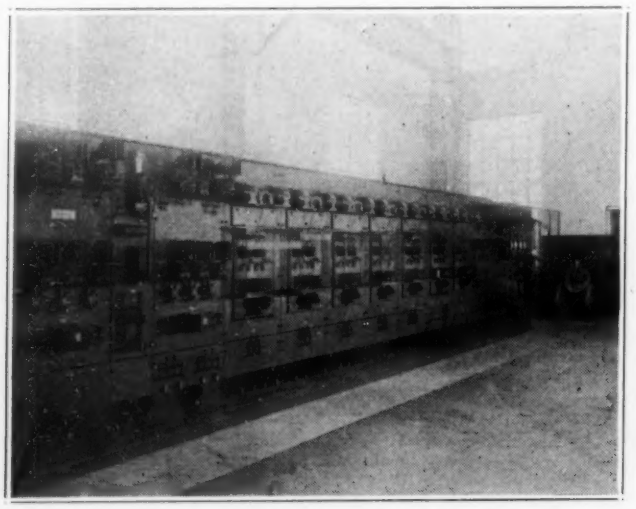


FIG. 10.

FIG. 11.

they are free from any tendency to hunt, and show no appreciable signs of wear in this service. The pilot generators and their variable ratio drives can be seen in Figure 7 and the regulator panels are shown in Figure 10.

As a matter of insurance, the vibrator motors were equipped with speed regulators of the same type as are used for the finishing stand drives. It has been found that the vibrators can be operated without artificial regulation by adjusting the motors for a speed slightly above the delivery speed of the last finishing stand. The metal between the last finishing stand and the vibrator is thus put under tension, but excessive tension can be avoided by giving the vibrator motor a drooping speed characteristic.

The nine main roll motors and the two vibrator motors are completely controlled from the desk shown in Figure 11. It will be noted that the desk has been made narrow and with a flat top and that the speed indicators and load indicators have been placed above the operator's head to give the maximum field of view. The field knife switches by which the motors can be reversed in emergencies can be seen on the wall opposite the instruments. One operator located at the desk controls the main motors, the vibrators and the switch which directs the strip into the desired vibrator.

In considering the drives for a proposed high speed tandem mill it is sometimes considered necessary to arrange the control so the entire mill can be operated at a slow speed at the start on a new rolling schedule, and the speed gradually increased as the correct adjustment of the relative speeds of the motors is obtained. No provision was made for this feature in this installation and experience has shown it to be unnecessary. For each section to be rolled the most desirable finishing speed is selected and the drafts and speeds of the individual stands adjusted to suit this speed. When the trial bar is rolled some of the finishing stands may be found to be incorrectly adjusted, as indicated by rapidly growing loops, due to variations in draft from the calculated drafts. The pulpit operator quickly checks the growth of the loops but allows the bar to be finished without making much effort to reduce the length of the loops even though they may contain from 5 to 50 feet of metal. The next bar comes through with little or no tendency to form loops.

When very light sections are being rolled, very slight variations in draft caused by change in temperature of the rolls, variations in the spring of the mill and other causes make it necessary to make compensating adjustments of motor speed. After the mill has been in operation for a time conditions become uniform and rolling can be continued for long periods with loops between finishing stands only a few inches high.

This mill has been operated for short periods without the speed regulators but not as satisfactorily as with the regulators. Other somewhat similar mills are being placed in operation in which the successful operation will depend on the inherent regulation of the machines; no artificial regulation being provided. The operation of these mills will be watched with great interest. Experience with this particular mill indicates that regardless of the method of regulation, and the degree of refinement required, the driving motors should be designed to be inherently stable and well matched over a wide range of loads so that the mill operator will not need to spend time correcting for inaccuracies in the driving equipment but can devote all his time to watching the mill.

Some of the Business Aspects of the Furnace Manufacturer†

By F. C. MANKER*

Editor's note: The following article is extremely interesting and it is our opinion that this is the first time anything of a like nature has appeared in the editorial columns of the Iron and Steel Engineer. While we do not altogether agree with the author's conclusions, nevertheless it reflects the manufacturer's convictions‡. It would be interesting for the operator and user of furnaces to present his side of this question and the columns of the Iron and Steel Engineer will gladly welcome any contribution of such a nature.

It has, undoubtedly, been customary in presenting papers before a technical society to deal with a subject which more or less directly concerns all of the members from the standpoint of engineering and scientific consideration and it occurs to me that perhaps there is an opportunity for the introduction of a little different viewpoint in some of the discussions which develop at these meetings.

The consideration of technical problems from the standpoint of the scientist or engineer perhaps is paralleled by studying a picture through a glass. It presents an opportunity for distorting one's perspec-

‡When this paper was written, Mr. Manker was associated with the Surface Combustion Company, Toledo, Ohio.

*Vice President, Great Lakes Steel Co., Ecourse, Detroit, Michigan.

†Presented at Annual Convention of the A. I. & S. E. E., June, 1929, at Pittsburgh, Pa.

tive and defeats the very purpose of its presentation. After all we are not attending these meetings with the expectation of memorizing a formula, or of collecting statistics on some particular item. We hope to broaden our viewpoint and understanding of our problem as a whole. A tendency, therefore, to restrict our thoughts to one phase only of our business may readily detract from the value of our services.

Technical viewpoints are of value to an organization when they represent conclusions based upon a premise that considers the overall picture of the company. How frequently the viewpoints of our engineers are rejected by management not because they are technically unsound but because the engineers have not considered their conclusions in proper relation with the policy of their organization.

A very illuminating experience recently developed when one of our Engineers brought two inventors into my office and proposed that we enter into a contract on a royalty basis for commercializing their development. Investigation showed they had arrived at a solution to a difficult engineering problem through the use of a combination of standard, well-established pieces of mechanical equipment. They had made application for patents covering this combination of equipment. They represented that a universal demand existed in the gas industry for this equipment and that it was becoming rather active among steel mills, particularly those having blast furnace gas of which they must dispose.

These three engineers were so taken with the correctness of their solution that they entirely overlooked the commercial aspect of the situation. I asked them one question: "What would you do when you present your case to a prospective buyer and he thanks you heartily for the information you have given him and proceeds to go out in the open market and buy the two necessary pieces of equipment you propose using? What would you get out of it?"

It was a dash of cold water to their aspirations and it made me feel badly, not so much for them, but because it typified a condition which exists so frequently throughout industry.

The contribution, which engineers have made and for which they have been entitled adequate recompense, if totaled up would represent a staggering sum. It is a peculiar thing that the engineer has contributed more to the physical comfort and welfare of the nation than any other profession. He has received recognition entirely inadequate and has achieved a standing in his community which generally is far short of that accorded other professional men.

This condition is certainly worthy of our thought. Why should it exist and is it necessary? In the first place, the very characteristic, which makes a successful engineer, in itself contains the certainty of commercial oblivion. The problem which absorbs the engineer is so intriguing, is so fascinating that its solution represents to him the greatest return for which he can hope. He usually asks for nothing more than the satisfaction of knowing he has solved a stubborn problem.

The rest of the world, however, do not regard life through the same eyes. As a matter of proper protection for his interest, it certainly behooves him to acquire an understanding of the viewpoint which will represent recognition from the community at large.

If the premise of increasing the individual's value to himself and his organization through developing sounder judgment based on a broader viewpoint is accepted, the thought may occur to you that such a premise is unrelated to the matter of combustion, fuel uses, furnace design or the furnace industry. There is, however, a very definite relation and a recognition of this will constitute a step in the line of progress.

It is fair to assume that this meeting is attended by those who are interested in the subject of combustion, of proper methods for the use of fuels, the design of equipment to accomplish specific heating results.

As combustion engineers, the lack of standards, which has prevailed throughout industry, has resulted in the terminology of combustion engineer being applied to the functions of a particular individual in various organization in a manner that is quite bewildering. It would clarify matters greatly if there could be established a generally accepted definition of what a combustion engineer is; what his responsibilities and duties are.

Such a standard would make it possible to set up a yard stick by which accomplishment could be measured. The lack of such a standard certainly works to the disadvantage of the combustion engineer. What he may consider successful and satisfactory performance, his management, through not appreciating his contribution, give a poor rating.

A definite standard of accepted performance and responsibilities which should be allocated to the combustion engineer, would make it possible to understand the requirements of his situation more thoroughly. He could conduct his work more intelligently on the basis of such an understanding.

If you go to a lawyer, or a doctor, or a banker, you approach him with a very clear knowledge of the responsibilities he is prepared to accept and the performance which you are entitled to expect from him. If you go to a combustion engineer, I believe you will find a difference of opinion as diversified as the number of men you interview in regard to what his responsibilities should be and what measure of performance you could use to judge his results.

In some plants the management will not allow their combustion engineers to visit other plants. In some plants the management will not allow their combustion engineers to design or construct equipment. In other plants the management expect their combustion engineers to be in touch with all new developments and to function as a construction and designing organization. Elsewhere the combustion engineer's main function is to set up standards of operating performance and to maintain constant control over this equipment to insure the performance standards being met.

Certainly, "if variety is the spice of life," a cross section among combustion engineers would produce spice cake.

There are, of course, good reasons for the development of such a situation. Frequently the limitations of organization or local plant conditions will necessitate an assumption of a multitude of unrelated

duties. This does not excuse our having thought our problem through to a clear cut conclusion. We must know what should be the relation between the management and the combustion engineer, and have a clear cut understanding of his generally accepted responsibility.

There is involved in such an understanding a good many questions which are not unrelated to proper business ethics. In the absence of any standards which would serve as a measure for comparison, the viewpoint developed is frequently one which ignores some important ethical consideration. A proper observance of these considerations, will reflect in the long run to the value of the individual and his organization. This also presents another problem which has to be developed through understanding with management. It can be solved only as management is educated to appreciate the combustion engineer's proper part in the scheme of production.

The question naturally arises, "How can management be approached to secure concurrence to these viewpoints?" Certainly if we begin to think more about these questions, if we begin to discuss them among ourselves and take home to our organization a viewpoint which is constructive, and is consistent, and maintain that viewpoint, it can be sold to any organization. It requires clear thinking, courage and constant effort to secure this recognition. The force of group action, as a result of group thinking, will bring results.

As combustion engineers, you are constantly in touch with the furnace manufacturer. Your relations with him are predicated upon two things:

First, Your function as you conceive it in your own organization

Second, The furnace manufacturers conception of his place in the scheme of things.

If both parties are to secure the maximum benefit from their contacts, it is essential that each have a clear understanding of his respective responsibilities; of the contribution the other party will make. It is, therefore, necessary for the furnace manufacturer to face his own problems just as you do; to set up for himself a proper conception of his responsibilities. The lack of such standards imposes uncertainty on your relations with him.

In the past the furnace manufacturer has frequently been confused in regard to his responsibilities with the combustion engineer. He has oftentimes played the role of consulting engineer without accepting the consulting engineers responsibilities and without compensation. He has been brought into this position through not understanding his responsibility to you and through his concurrence with your viewpoints.

If the furnace manufacturer is to represent to you an essential source of equipment, he must take a position which will enable him to carry on business at a profit. He must function as a clearing house for placing at your disposal experience throughout industry. He must establish research upon a basis of continuous effort to bring to you in terms of finished equipment the answer to your problems. He can not afford to compromise with his position as a furnace manufacturer in order to function as a consulting engineer gratis to meet the viewpoint of some local management. He must establish definite standards upon which he expects his performance to be judged. His equipment must be sold upon a basis which is uniform, which offers to the purchaser the maximum of protection, which assures the purchaser that he has accepted all of the responsibilities which are his and in turn places upon the purchaser the responsibility belonging to him.

Such a situation can only be developed through intelligent effort and co-operation between the engineer and the furnace manufacturer.

Sometimes peculiar situations arise which are due to the lack of standards referred to previously. One of the most common is a feeling of competition which somehow develops between the engineer and the furnace manufacturer.

Apparently the manufacturer enters the picture with equipment for sale. In the course of negotiations he assumes the role of consulting engineer to solve a specific problem for the purchaser gratis. When the engineer has the solution handed to him, he is confronted with a temptation to enter into the furnace manufacturing business himself. He sees the opportunity to save money for his company; to build up for himself some additional credit with the management. He puts his own bricklayer gang at the work of constructing the equipment in question. Such situations are not uncommon. They can result in nothing but harm to the engineer, his company and to the furnace manufacturer.

It can hardly be called a fair proposition. In order to protect the sale of equipment, the manufacturer supplies information only to find that his very effort to protect the sale has placed him in an untenable position. Such experiences must be paid for by someone. The sales expense, the engineering expense must be absorbed on some other job. It is certainly unsound to lose business on the basis of the purchaser changing the premise for doing business after he has secured information which was unavailable without the assistance of the furnace manufacturer.

From the standpoint of the combustion engineer, it is not such a good thing either. He is taking a responsibility which may terminate his growth with his own organization. Perhaps the furnace manufacturer has not given him all of the information. His project is a failure. He has let the company in for a considerable expenditure without any opportunity of securing redress for failure. The company's alternative is to fire the engineer. If they do not fire him, his recommendations are certainly discredited for a long time.

From the company's standpoint, it is a poor risk which usually represents a capital investment excessive compared with equipment purchased on the basis of definite performance.

Not so long ago an engineer convinced the management he had an idea in furnace design for an annealing operation. The company made application for patents, which were construction patents only, and voted an appropriation of $40,000 to build this furnace. At the end of eighteen months their total expenditure amounted to $112,000. They had failed to ship a ton of material from this furnace. In the meantime their competitors had taken away from them several customers. Their old facilities would not meet the standards of their competitors, who were using equipment purchased from furnace manufacturers.

So this mill, in addition to losing $112,000, lost many additional thousands through business taken away from them; and the most serious loss was a reputation for producing a quality product. At the end of eighteen months a new president came into office. He appreciated the seriousness of the situation. They immediately purchased equipment which they knew would have to produce a quality product because it was backed by a manufacturer of experience.

Examples of this kind are innumerable. I venture to say everyone of us has been in situations where someone, either the engineer or the furnace manufacturer, has had to assume responsibilities far beyond his legitimate function.

It is not my intention to over emphasize the contribution of the furnace manufacturer. It must be recognized that any successful installation is dependent upon the experience of the mill and the experience of the furnace manufacturer being coordinated and expressed in the proper equipment. The problem, however, is to set up for each situation the contribution which each party can legitimately make.

As an example, we can classify all of the inquiries for furnace work under three general headings. First—Those inquiries which have been well standardized. Second—Those inquiries covering installations which require development work.

The furnace manufacturer appropriates sufficient funds to carry on research and takes the burden of the entire experimental expense. The mill is relieved of any risk involved in the furnace builders problem. The mill, however, must take the responsibility for providing the furnace manufacturer with complete information on the process, and opportunity to collect data in the field on which to base development work.

The furnace manufacturer is justified in accepting the problem, because its solution will enable him to immediately sell a great number of furnaces to other companies who have in the past been only potential customers. Third—The third classification consists of inquiries which represent a problem that is peculiar to one company.

In this case the furnace manufacturer is not in a position to accept any responsibility for research and development expenditures because such development work would not result in building up opportunities for future business.

A case comes to mind of an inquiry received from a manufacturer in Connecticut. He wanted a continuous enameling furnace and thought we would be interested in developing such a furnace for him. Upon writing to find out what his specifications were, we learned that he was a maker of watch dials. He had in mind buying a continuous furnace for enameling watch dials. He would pay not over $1,000 after we had developed a furnace especially fitted for this, made the installation and operated it successfully in his plant. Of course, the potential of furnaces of this type represented an incentive out of proportion to the development expense involved. It was not desirable business.

We advised the gentleman that his problem could be undertaken only on a basis whereby he paid for all development work plus a profit and accepted the solution which was finally produced without further obligation. The gentleman of the watch dials decided he would continue baking enamel in the standard tray oven.

If the furnace manufacturer has nothing to contribute to industry, he should not exist. If the furnace manufacturer has a contribution to make, which is valuable to industry, his business should be carried on so that he could show a reasonable profit. It is my contention that industry needs the furnace manufacturer; that only through him can industry make rapid progress.

Whenever a business situation develops that threatens his position, it becomes a matter of concern not only for the furnace manufacturer but for industry itself. Business today is appreciating the error of attempting to purchase on the basis of no profit to the supplier. Business is recognizing that every industry is entitled to make a fair return for its contribution and unless the furnace manufacturer and the combustion engineer each determine a program insuring proper business considerations to their functioning there is an economic loss to industry at large which is serious.

There is a definite relation between the furnace manufacturer's understanding of his business problem and the contribution which he has made to industry. The conception outlined previously might be considered theoretical unless we had at least a few striking examples of the contributions the furnace manufacturer has made.

In the evolution from bricklayer to business man, his responsibilities have increased from the "rule of thumb" built furnace equipment to equipment produced as a result of process development studies. He started with building, for heat treating operations, a square furnace with a door in one end or perhaps both ends. No doubt, the second door was a startling innovation. He used coal for fuel. What was done with the furnace after he built it, he had no idea. The man who operated the equipment wrote his own ticket and held his job if the product happened to stand up in the field. Conditions have changed.

The metallurgist, the chemist, the advent of science into the practical manufacturing operation, changes in specifications, new products and new methods have resulted in the automatic machines called furnaces that do your work today. The modern furnace manufacturer employs the best mechanical, electrical, chemical and metallurgical engineers that he can find. He uses fuels susceptible to control within ranges of operation formerly unknown. He takes your product and sells you a lowered cost production which answers every requirement you have set up. There is no longer a place for the "guesstimate" method of furnace building. As these changes have come about they have been evidenced by improved equipment and increased capacity to render you specialized service.

Since you are interested in the steel industry primarily, we will take two examples of furnace operations in the steel industry and one from the automobile industry, illustrating the change in the complexion of the furnace business which is typical of the results of the furnace manufacturer finding himself.

Some time ago a new process was developed for making castings of a certain type in an automatic

machine. The inventors with home-made heat treating equipment and small production were able to produce a machinable product by very crude methods. Since the heat treatment they established was crude, their conclusions in regard to the requirements of their product were found to be impractical when a big interest decided to adopt the casting process for immense production.

The furnace manufacturers were called in to quote on specifications which had been prepared on the basis of the information available through the engineer of the inventor. The result was a flood of quotations proposing every conceivable type of furnace construction. One furnace company, however, proceeded to establish the true matellurgical requirements of the product before making a quotation. As a result of their investigation, specifications were completely changed and furnaces were installed at a fraction of the original contemplated cost because the heat treating operation was really extremely simple.

The following comparisons are resumes of the tests showing the premise for heat treatment set up

FIG. 1—Bendix Housings, showing sand core and sprue. Near the fins, the metal was too hard to be filed. After annealing the hard spots vanished.

FIG. 2—Shock Absorber Housing, partly finished.

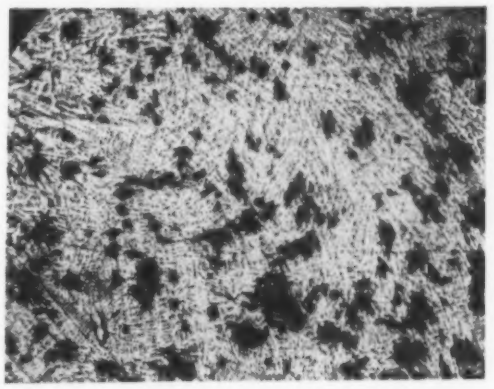


FIG. 3—Typical hard spot. Edge of ear. Rockwell B 120, C 57, white iron, X 100.

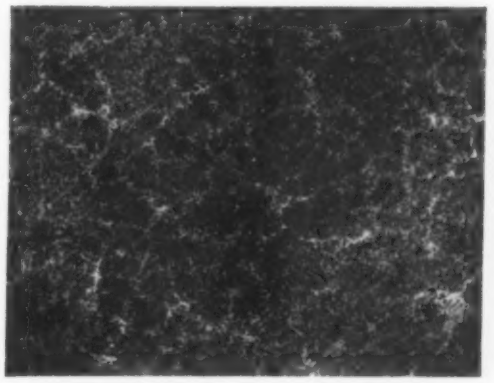


FIG. 4—Center of ear. Rockwell B 106, C 31, Gray Iron—X 100.

FIG. 5—Bendix annealed at 1650 degrees, held 20 minutes, cooled in air. Rockwell B 81, X 100.

by the customer and the actual specifications developed by the engineers of the furnace company.

The next example coming to mind has to do with a situation in the steel industry which has caused the wire manufacturers considerable concern. You are probably aware in a general way of the changes which have taken place in the production of bolts and especially those used in the automobile industry. If bolts had to be produced today with turned threads it would be a very severe handicap and would reflect in a cost that undoubtedly would restrict the distribution of automobiles. A further

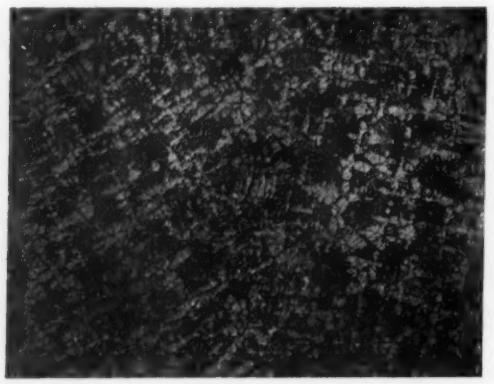


FIG. 6—Same as Fig. 5 cooled in furnace, Rockwell B 85, X 100.

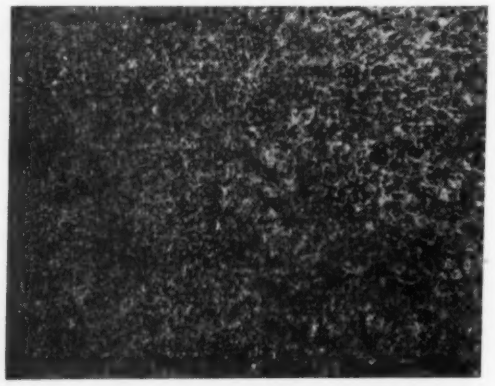


FIG. 7—White portion of ear annealed at 1450 degrees, held 90 minutes, cooled in air. Rockwell B 92, X 100.

FIG. 8—Gray portion of ear annealed at 1450 degrees, held 90 minutes, cooled in air. Rockwell B 92, X 100.

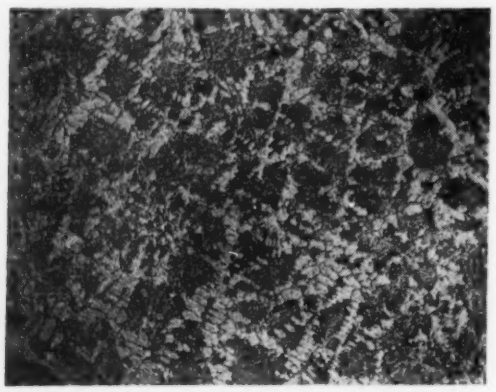


FIG. 9—Bendix annealed at 1400 degrees, held 10 minutes, cooled in air. Rockwell B 87, X 100.

FIG. 10—Same as Fig. 9, held 20 minutes. Rockwell B 89, X 100.

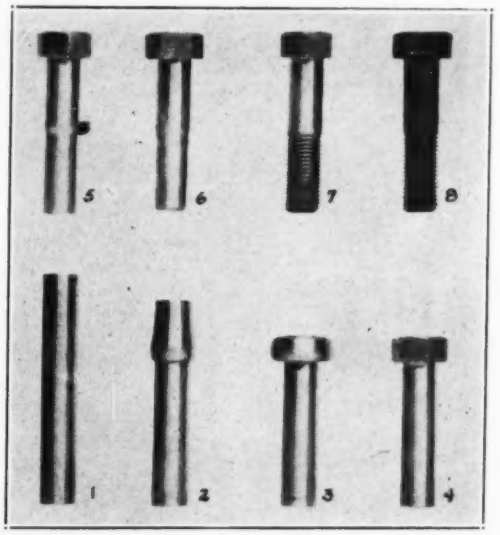


FIG. 11—Typical product made from normalized wire.

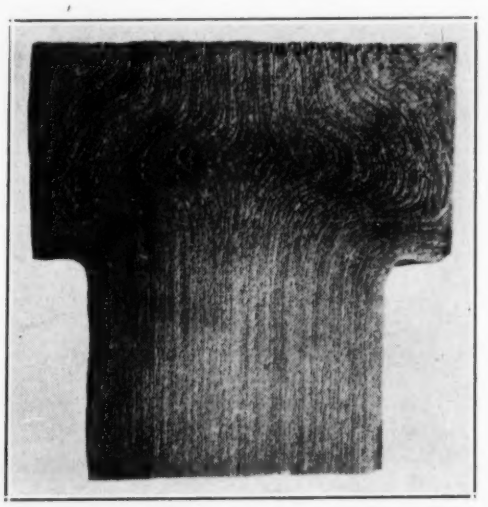


FIG. 12—Section of head showing the flow of metal.

factor than the cost, however, is the increase in quality of these bolts. The changes in specifications for material has put on the wire manufacturer a problem of production and he in turn has gone to the furnace manufacturer to solve the key to the situation, which is the heat treatment at a proper cost.

The following data will show a comparison be-

tween the heat treatment which the mill thought correct and the heat treatment which the metallurgist of the furnace manufacturer established as a commercial requirement to meet the needs of the screw and bolt maker. I do not mean to question in any way the metallurgy of the wire manufacturer because his analysis perhaps applies if the heat treating equipment and operation is carried on in conventional fashion. The production would, however, demand a uniformity in production at a cost which makes necessary radical departure from conventional methods. The solution of this problem was the result of over a year's investigation. It was arrived at through the combined efforts of the wire and the furnace manufacturer's organizations. The accomplishment certainly is noteworthy as representing an achievement possible only under proper relationships between the parties interested.

The third and last adventure, which may seem a strange word but I think is correct, of the furnace manufacturer is the example of his keeping step with requirements in sheet mills.

The other day an article appeared on the "Characteristics of Auto Body Sheets" which points out distinctly the remarkable evolution in specifications for this material since 1910. Changes in body design and production have resulted in the steel mill producing a new product to meet the requirements today. In general there are four heat treating specifications to be met and it is interesting to note that

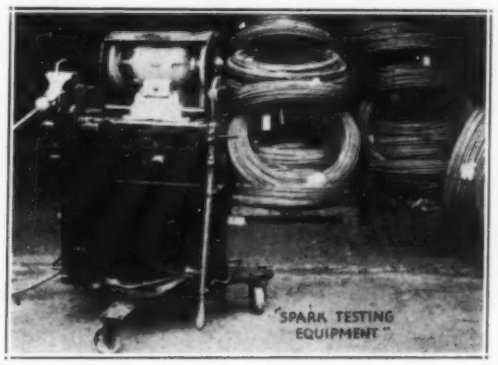


FIG. 13—Wire testing equipment. Decarburization is indicated by the appearance of the sparks. Pipe is detected by bending in the vise.

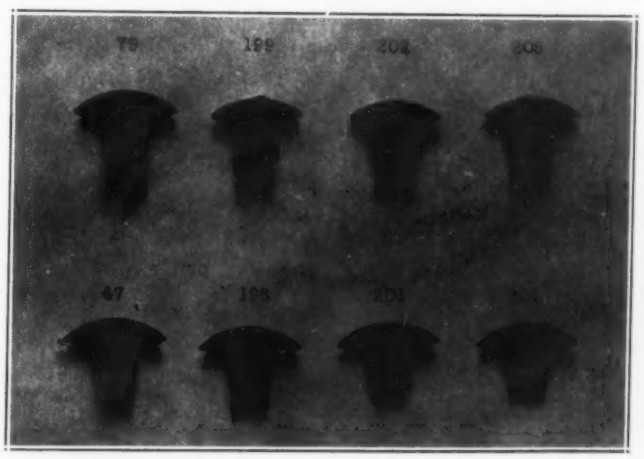


FIG. 14—Some of the heads show fractures because the metal was too hard.

along with improved steel mill process the furnace manufacturer has developed equipment to meet the metallurgy the steel mill requires.

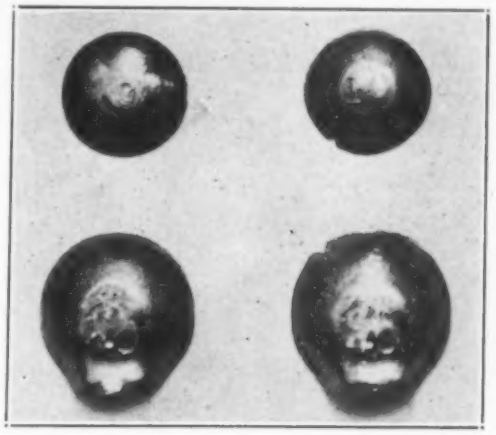


FIG. 15—O. K. and fractured heads.

When it was found that box annealing in combination with the method of loose sheet rolling, which came into use about 1925, did not produce the quality required, the method of open annealing

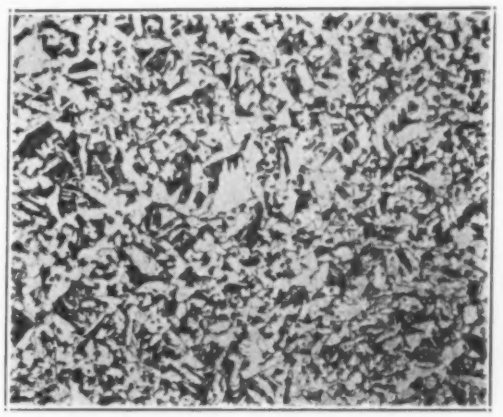


FIG. 16—Structure of O. K. head. 5/16 in. stock normalized at 1650 degrees with 3 hr. cycle. 23 carbon RB 78.

or normalizing began to be used. Furnaces were built having in mind heating the sheets as rapidly as possible and bringing them out into the open air for cooling. Today these furnaces are built with cooling chambers which recognize that it matters

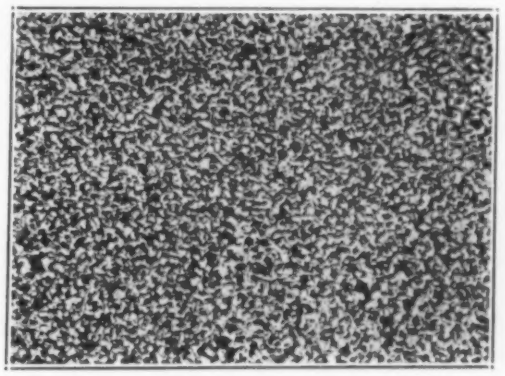


FIG. 17—Structure of broken head, not normalized. RB 75.

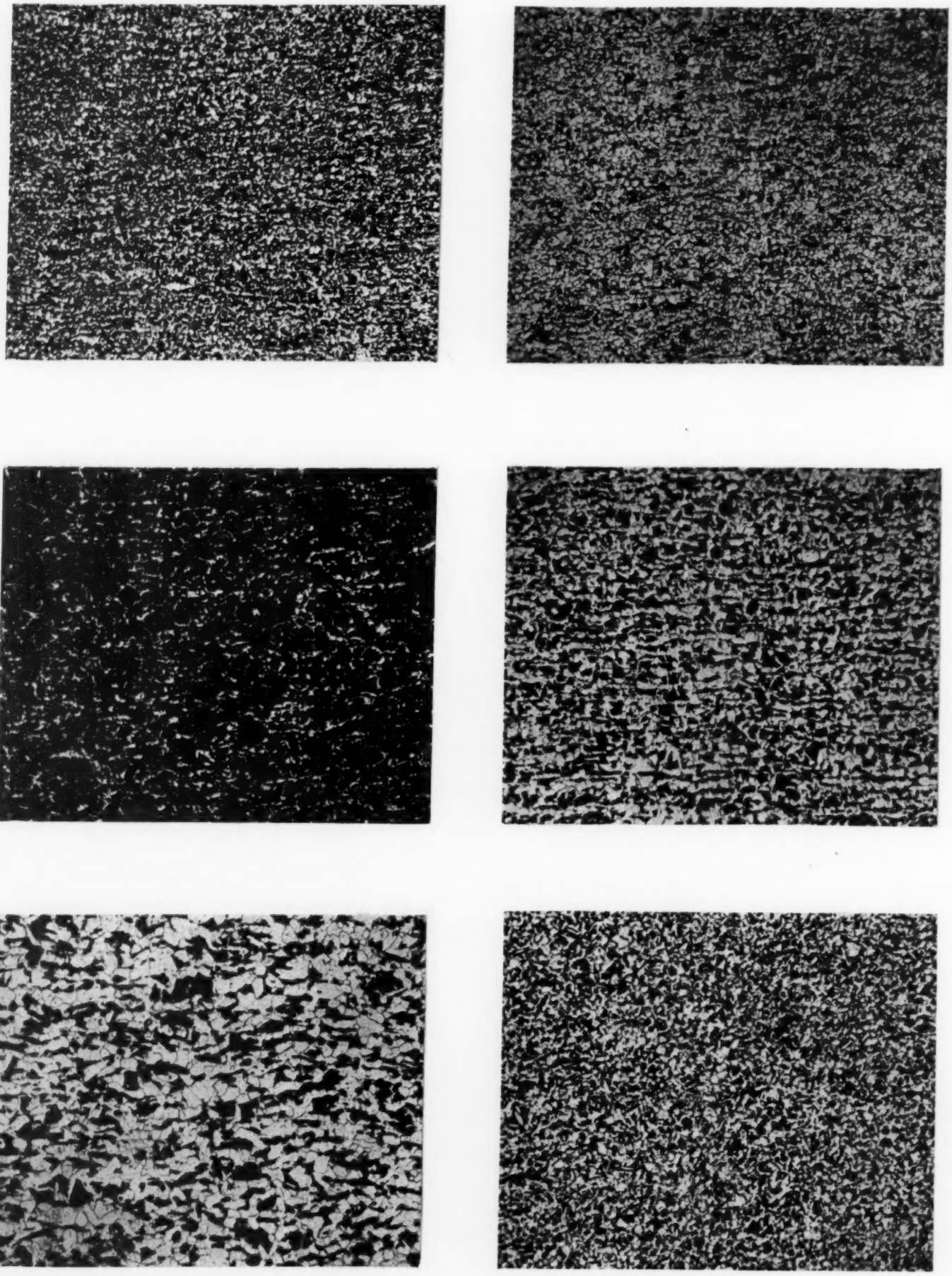


FIG. 18.

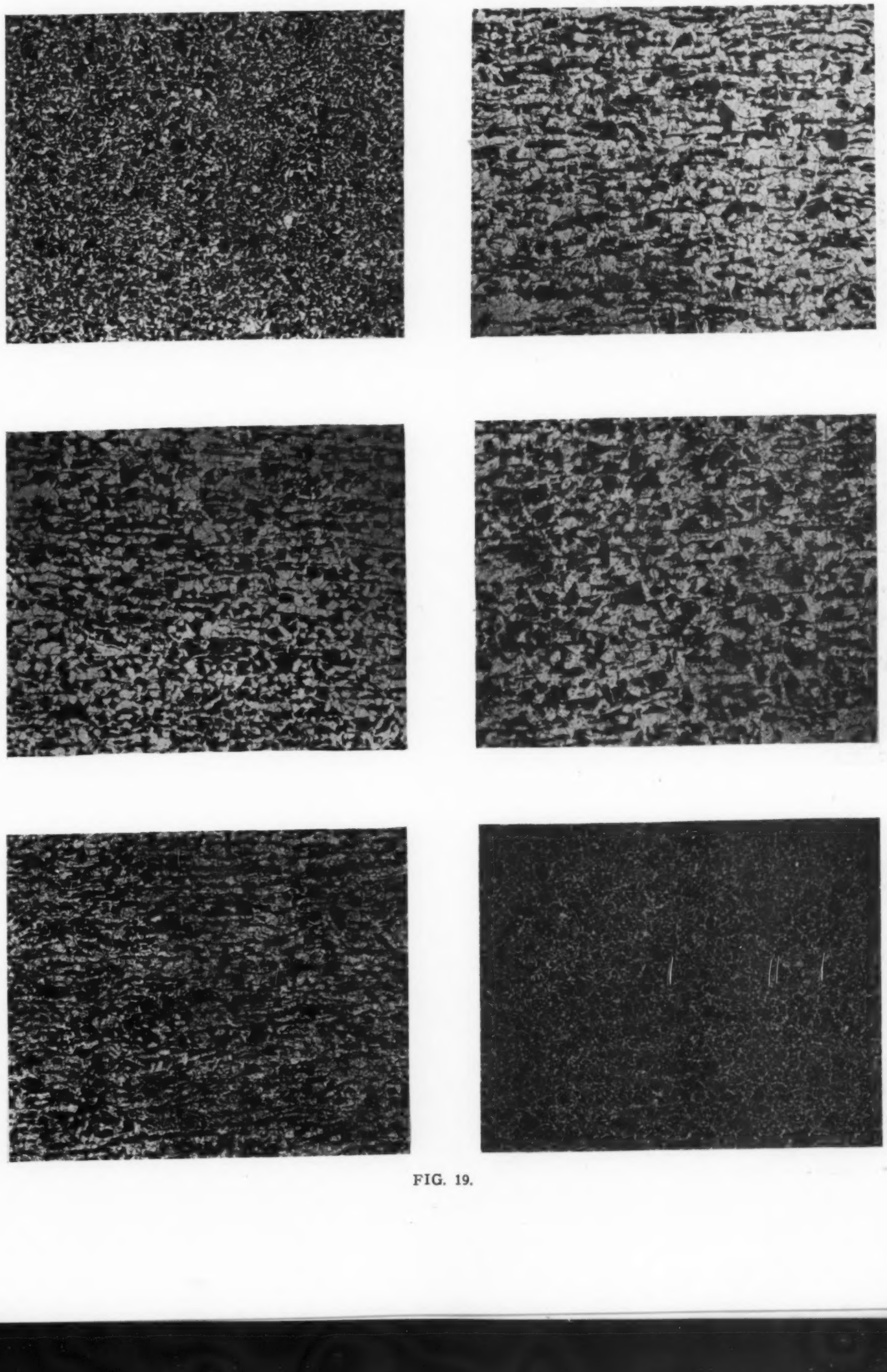
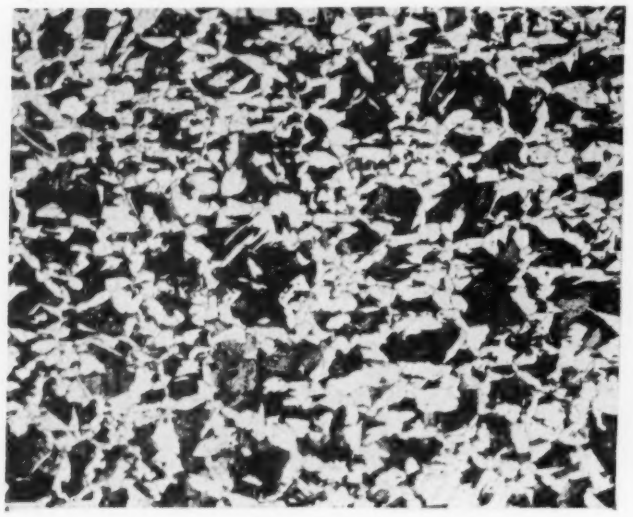
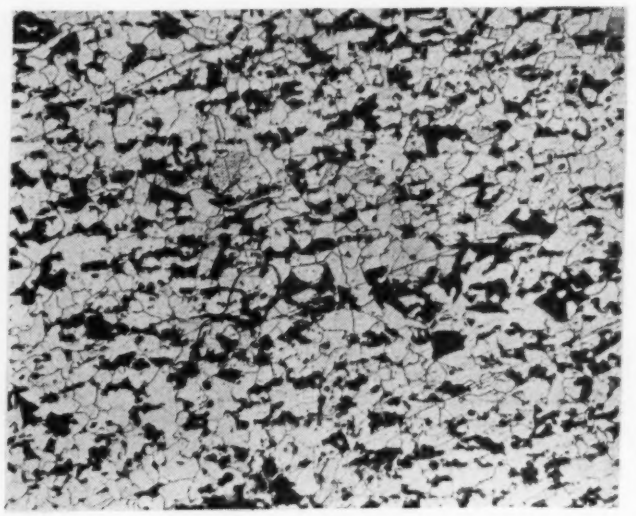


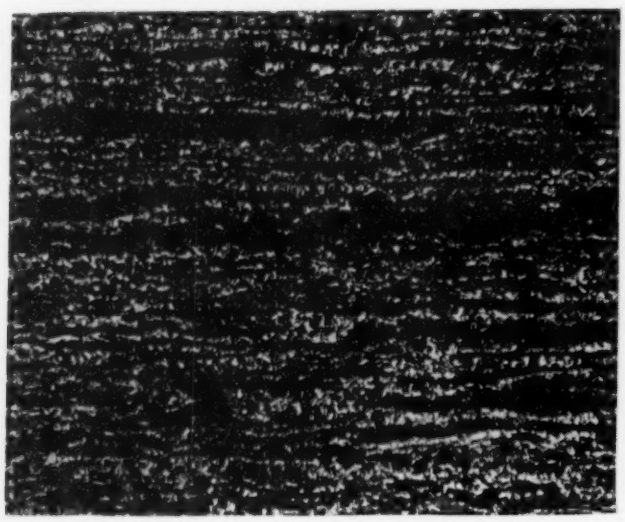
FIG. 19.

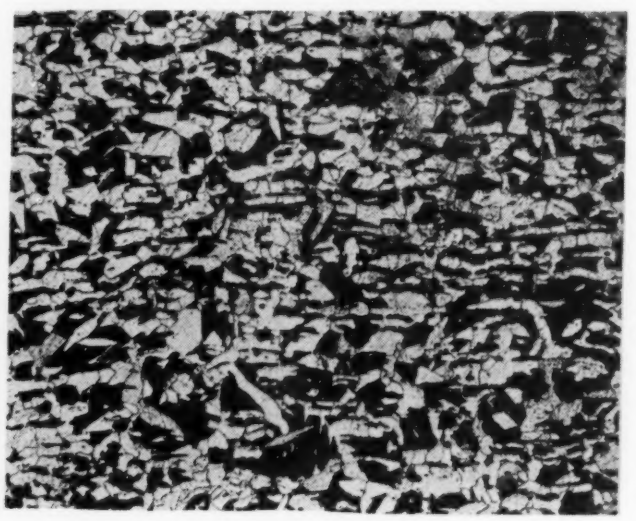
Test 18—40 min. 0.8 0_2. 20 min. Pick. time.

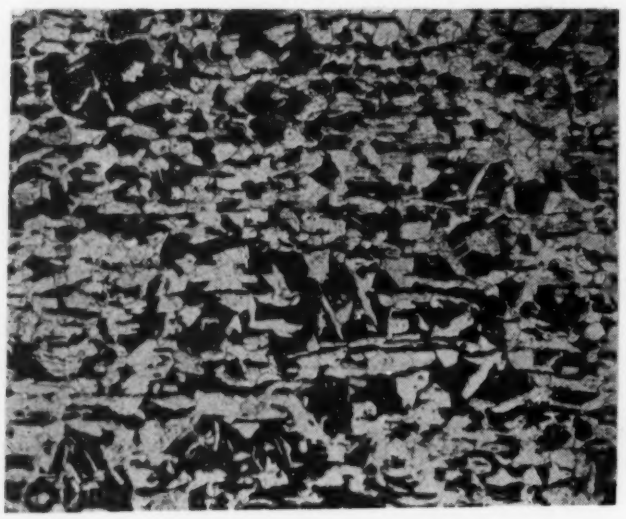


Test 20—40 min. 1.6 0_2. 27 min. Pick. time.









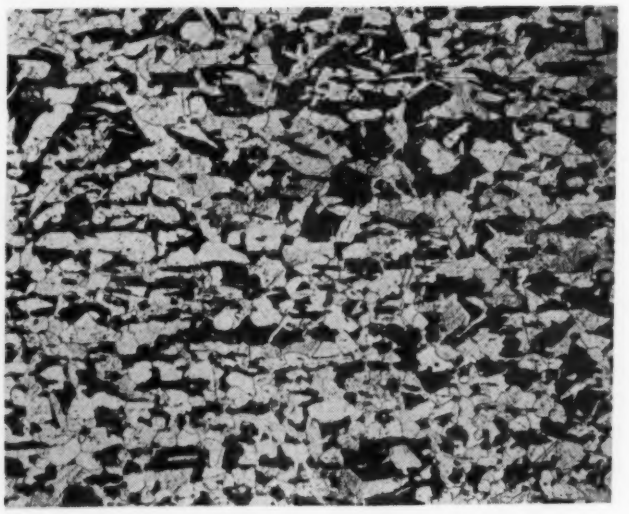
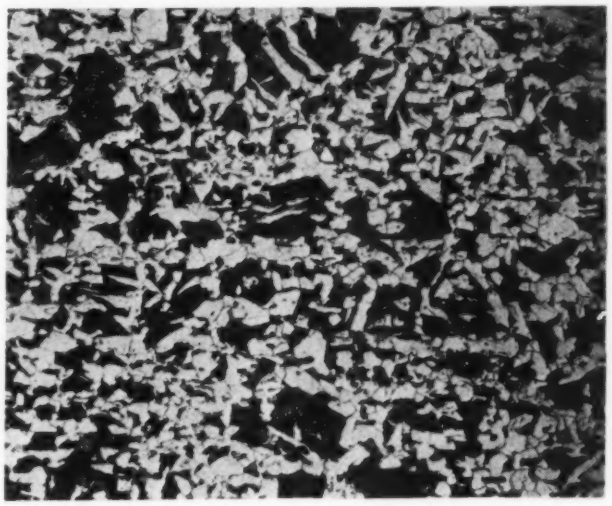
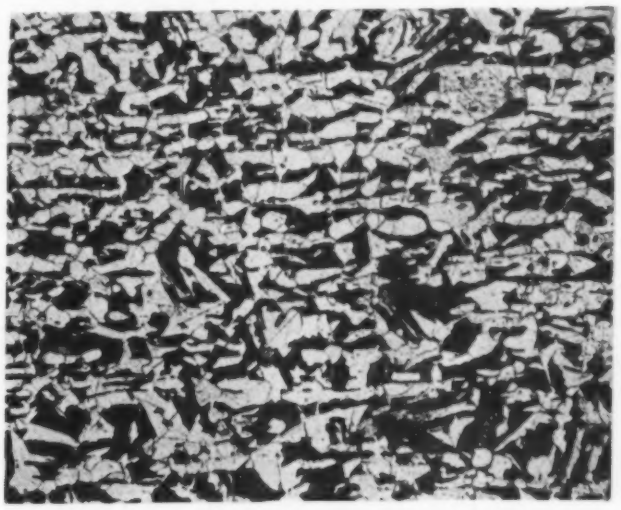


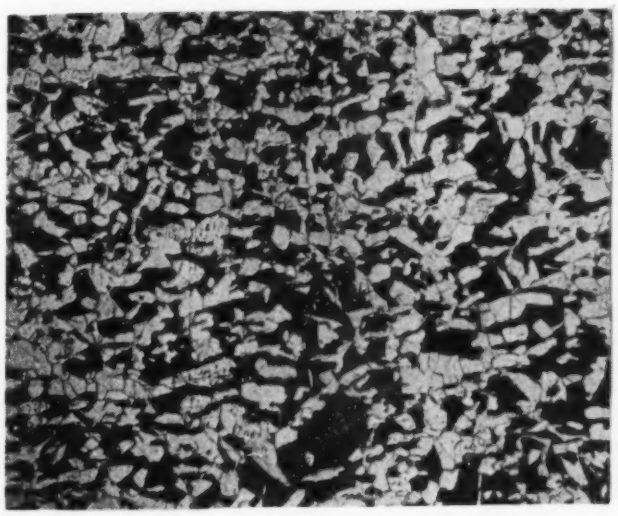
FIG. 20.

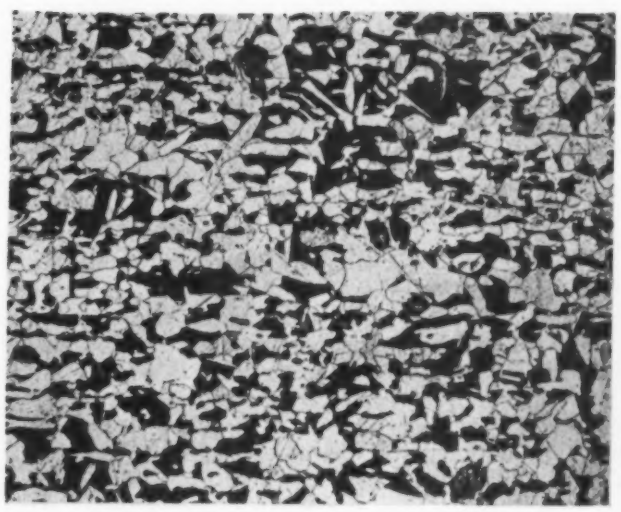
Test 18—40 min. 0.8 0_2. 20 min. Pick. time.

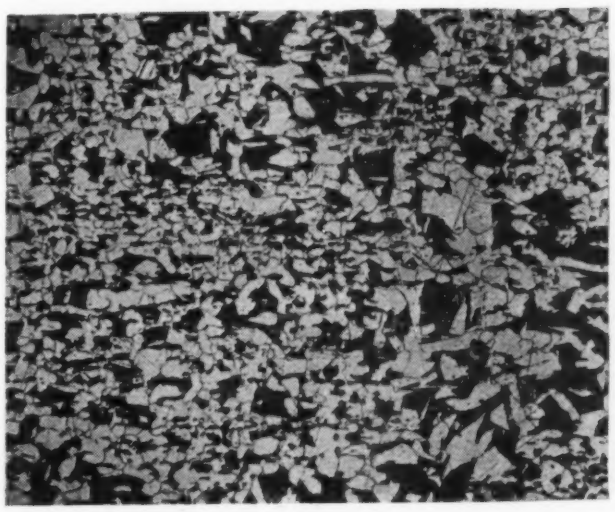


Test 20—40 min. 1.6 0_2. 27 min. Pick. time.









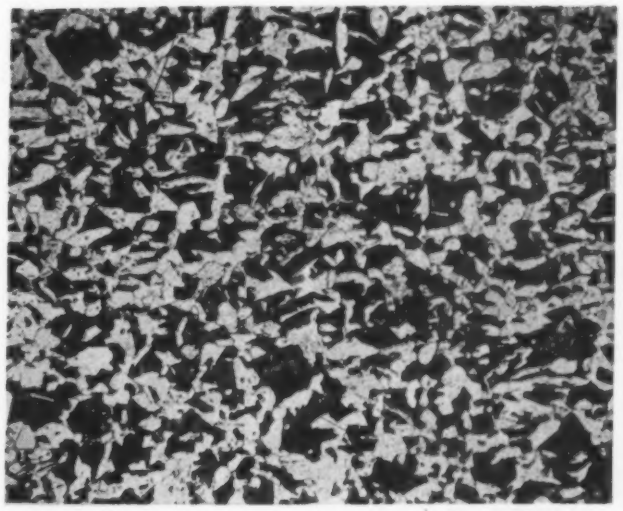


FIG. 21.

little on what heat cycle the top temperature is reached but that extreme flexibility is necessary to control the cooling rate to produce the combination of grain structure and physical properties to meet the demands of the trade.

The following curves indicate the various combinations which are possible with the furnaces today as well as the curve which was typical of the original open annealing furnace without cooling chamber.

The curve E is typical of the first step in open annealing without cooling chambers.

The curve A produces a large grain material with a Rockwell of 40-45. It is used normally for single pickle stock where box annealed is too soft, when deep drawing is essential and stiffness not so important. Enamel stock, bed post tubing and window tube heading are typical uses.

The curve B produces a large grain with higher Rockwell of 50. This cycle is one of the most popular, being used for fender stock and similar purposes, where deep draws exist and stiffness is necessary.

The curve C produces small grain with Rockwell of 50. Radiator shells, upper back, and cowell are typical uses. It meets the requirement of deep drawing where sharp bends exist and stiffness is not required.

The curve D produces small grain size with Rockwell approximately 60. Where extreme stiffness is essential and sharp bends should not show grain roughness such as furniture stock, or door panels, it is widely used.

These examples of accomplishment are not mentioned with the thought of extraordinary performance but because they typify the results which may be expected when the furnace manufacturer knows his business and the proper relations are established with industry.

If we accept success as an expected thing when our premise of relationships is correct, then we are ready to look into the future, to visualize of possible something of the place which the furnace manufacturer might fill in industry.

You can be certain that he will study your problem with a view to justifying this research for producing better equipment for you. He will compliment your own engineers and research organization to anticipate your process developments with proper equipment. He will free you from the risk and time involved in the development of equipment to meet heating problems. He will act as a clearing house to unite nation wide experience with the latest developments in materials to produce improved heating machines. He will do this on a basis of lowering your production costs and reducing your capital investment risks.

On this basis I believe the furnace manufacturer is entitled to consideration and support from industry.

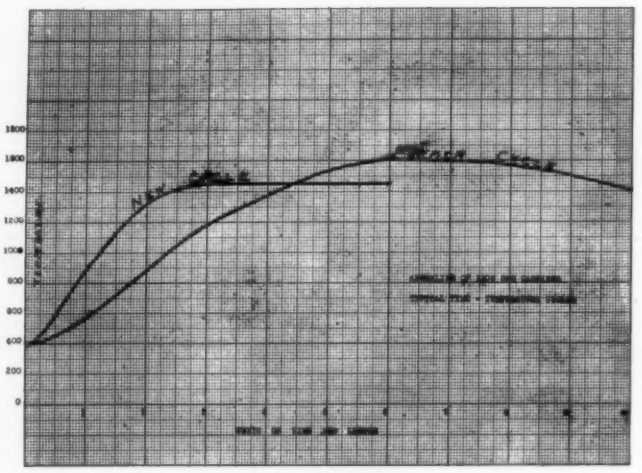


FIG. 22.

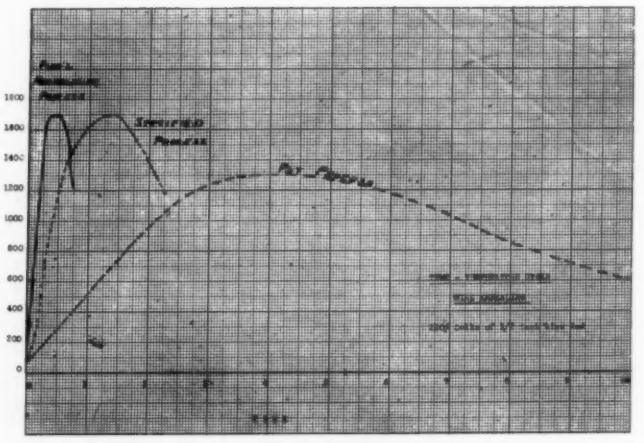


FIG. 23.

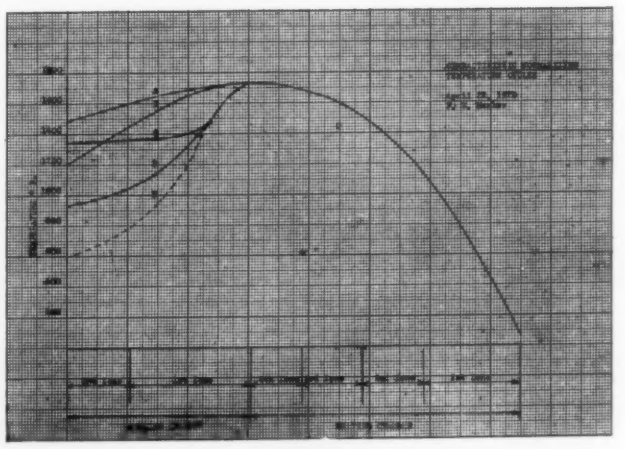


FIG. 24.

A. I. & S. E. E. Meeting

CHICAGO SECTION

F. W. ACKER, Chairman — A. J. WHITCOMB, Secretary

WEDNESDAY, JANUARY 15, 1930

ELECTRIC POWER CLUB — CHICAGO, ILL.

"TAPERED ROLLER BEARINGS AND THE APPLICABILITY TO STEEL MILL EQUIPMENT"

F. WALDORF, Mgr. Steel Mill Division, Timken Roller Bearing Co., Canton, Ohio.

The Incorporation of Safety in Electric Station Design*

By V. R. BACON†

Discussion

Discussed by

Fred O. Schnure, Supt. Elec. Dept., Bethlehem Steel Company, Sparrows Point, Md.
Walter H. Burr, Elec. Supt., Lukens Steel Company, Coatesville, Pa.
R. M. Fuller, Consulting Engineer, Riverton, N. J.
John C. Reed, Elec. Engineer, Bethlehem Steel Company, Steelton, Pa.
John McTamney, Elec. Dept., Midvale Steel Company, Nicetown, Philadelphia, Pa.
W. A. Kates, Engineer, United Engineers & Constructors, Philadelphia, Pa.
J. A. Northwood, Safety Engineer, Bethlehem Steel Company, Sparrows Point, Md.

Fred O. Schnure: I feel the Association is very much indebted to Mr. Bacon for his paper on the incorporation of safe practice in high tension station design. I also feel that he has covered the situation very thoroughly. Practically every point that he mentioned must be considered in the application of switching equipment in steel plants having power plants of some size.

One of the things he mentioned, namely, the communication system put me in mind very forcibly of an instance which occurred in our plant when it was being developed, and where we depend entirely on the standard telephone system for communication to our various substations and power houses. At that time our transmission system had not been completed, and we were compelled to go in a round about way to re-establish power in case of a failure. One of our men was located out in one of the mills at a strategic point when trouble occurred, and he had to use a phone with an extension that was being used by the test department in calling off test numbers. After waiting for the phone for some time he finally grabbed a pair of pliers from one of the electricians, rushed out and snapped off this extension wire. That was an instance which led to the establishment of a private telephone system between our various substations, to which has been added a second private telephone system between the power house and the various pump houses and boiler houses.

A short circuit study of any power system should be made periodically, if additions are being made either to the generating or in synchronous equipment to the consuming end of the line. We anticipated the necessity of this short circuit study about five years ago, and started in a way to bring our system up to snuff, but we were not quite fast enough. Disaster overtook us a year or so ago and we lost a lot of equipment, and had to speed up our campaign. The large manufacturers of switching equipment or the power company serving your plant are in a position to set up your system on a test board to ascertain the system's short circuit capacity.

There is one thing for which you have to watch. Switches that were rated at 30,000 amps. interrupting duty ten years ago are down to 9,000 now. You cannot blame this derating on the manufacturer of the switch, because if you go back fifteen years you recollect a 5,000 k.w. turbine was a good sized turbine, and a 50,000 k.w. system was a rather large transmission system. I remember ten years ago when magnetizing and starting switches for motor generator sets were applied on the amp. principle, that is for 1,000 k.w. set one would apply 200 amp. switch. If the system has a short circuit capacity of 30,000 amps we must have a switch that has an interrupting and thermal capacity of at least 30,000 amps.

Mr. Bacon mentioned water and carbon dioxide as fire prevention agents. I might say that we pipe steam up to our generators, have used it once, and were able to put the machine back on the line in ten minutes, with no damage to the windings.

I have not had much experience on group phase versus isolated phase bus structures, but I do not see a great need for isolated phase structures in industrial plants. If any trouble develops, you are just as apt to get a ground as to have a short between phases. I do not think for a 6600 volt system the isolated phase is worth considering.

In a study of our system, contemplating the use of remote gang operating disconnecting switches, we ran against this situation—that remote operated switches, gang operating switches—were not listed in sizes large enough for us to use, as we required switches of 3000 amps capacity. We did not ask for them because it was one man's job to put one of these switches in at a time, and we did not see how one man could put in three of them as in a gang operated switch.

Water-cooled transformers have caused us considerable trouble, and wherever possible I think cooling coils should be omitted. I believe the manufacturers agree with us in that belief.

Walter H. Burr: We have listened tonight to one of the most carefully prepared papers it has

*Presented at Philadelphia Section, A. I. & S. E. E., and Annual Convention, Pittsburgh, Pa., June, 1929.

†United Engineers and Constructors Co., Philadelphia, Pa.

been my privilege to hear in this Engineer's Club. Mr. Bacon has covered his subject very thoroughly. There are a few points that have occurred to me which I would like to mention in connection with this paper.

Whenever I have occasion to install new electrical stations, one of my first considerations is elevation, especially with reference to flood water conditions. A study should be made of the head waters of the stream and the capacity of dams if there are any on this water shed. If this is not done very serious damage may result to the electrical equipment in the station and even though a reasonable allowance is made for extraordinary conditions the breaking of a dam may result in great losses.

In modern station it is necessary to provide air ducts for proper ventilation of electrical equipment. Frequently these are underground and every precaution should be taken to make sure these are water tight. While fans are in operation the water will usually be evaporated, but if a shut down occurs the accumulation of water may be forced out by the fans into the windings of the electrical equipment, when starting up.

The speaker made reference to couplings on motor generator sets. Recently the State Safety Inspector called our attention to a coupling on a small motor generator set which although it was perfectly smooth he requested it be guarded. This is mentioned simply to bring this matter to the attention of the manufacturers of electrical equipment as this guarding can be done very easily while machines are in the factory.

Reference was made to insulating material which is being substituted for concrete in cell structures.

Careful provision should be made for proper ventilation of buildings, especially where the station is not provided with heating equipment. Changes in temperature and humidity may cause condensation on all structure material if not properly ventilated.

Mr. Fred Schnure referred to private telephone systems between various stations on power system. It is not only essential to have this telephone system, but if possible it should be so located that disturbance on the electrical system will not make this private telephone line inoperative at the time when most needed.

Mr. Bacon referred to the proper selection of series transformers. Too much stress cannot be brought to bear on this point for I believe this is one of the most frequent sources of trouble in power stations.

I would like to ask Mr. Bacon what he considers the most suitable material for roofs in substations and power houses where condensation is so apt to take place; also if there is a standard DC voltage for the tripping circuit on remote controlled oil switches. I refer to the source of DC power supplied by small storage batteries used to trip oil switches when the closing voltage for these switches is supplied from regular DC, 230 volt shop system.

R. M. Fuller: We probably listened tonight to one of the most comprehensive papers in existence on safety in central station design; at least I have never heard another one, or read another one, that covered the points so thoroughly. It only goes to show how far the central station designer goes nowadays, not only to insure men and equipment, but continuity of service. If the large station goes to this extent in this matter of safety, it is just as vital a matter to the industrial plant or smaller power station to take like precautions, because failure of equipment in a smaller plant is frequently more serious financial loss than the failure of like equipment would be to the larger operating company.. Smaller plants are very frequently handicapped after the original plant is built, because equipment is added for which there is insufficient room and safety is lost sight of. In this case it becomes the duty of the engineer to educate the management to make sufficient appropriation so that in the design and installation of equipment safety can be cared for.

John C. Reed: I have not been coming down here very much lately and I have no new stories, but this paper tonight, by Mr. Bacon, is one which I am sure I have enjoyed and which I think all of us have enjoyed. With his various duties in a Steel Plant, it is impossible for an Electrical Engineer to become an expert on all the lines of activity into which he is drawn, and the next best thing to knowing how to do a thing is to know where to go to find out how to do it, and I am sure Mr. Bacon's paper, which we will have published in complete detail, will be a source of information to which all of us can go whenever we want to make additions or subtractions to or from our present power systems. Whenever we find we have something new to put in, the first thing we do is to scout around and find out where we can get our information. I am sure this paper is one which I am going to have recorded on my card index as one for safety in regard to power houses.

To speak more fully along the line of safety, most of you gentlemen do not know what safety is. If you had your plant within three miles of the State Capitol you would know something about safety. Whenever those fellows at Harrisburg strike a nice day and want to take some time off, they say, "We will drive down to Steelton and look around." The result has been that Steelton is one of the safest places on earth.

I asked an inspector some time ago: "Why make us do this, that and the other thing? Why don't you go around to the other plants and see what is being done?" He said, "We are going to make this Steel Plant a model plant and every time visitors come to Harrisburg we are going to bring them over here and show them what has been been done."

Some of you gentlemen have no doubt been getting by without doing a lot of things which the Department of Labor and Industry thinks are necessary, but unless I am misinformed, you will all be required to do them sooner or later. The Steelton Plant had the best record in the Bethlehem Steel Corporation for accident prevention last year, and when an Open Hearth Plant of the size of that at Steelton can run for over nine months without a single lost time accident, and the Electrical Department with over three hundred and fifty men can function for over ten months without a lost time accident, you must admit things are reasonably safe.

John McTamney: About all I have to add is, I have enjoyed the paper very much. I think as Mr. Reed said, to have that on file would be very valuable to us.

I would like to ask Mr. Schnure the cause of his water-cooled transformer failure?

Fred Schnure: One failure was due I believe, to the iron loosening and causing vibration on certain leads. This vibration caused a cooling coil to wear through at one of its supports.

W. A. Kates: I think that some of the things which may appear very fundamental in design are quite frequently overlooked, and some of the things which Mr. Bacon has brought out in his paper which may seem ordinary commonsense fundamentals, are very frequently given too little thought. One of the special features mentioned was providing suitable exits, etc. One would naturally think that any plant layout would consider exits and doors very carefully with relation to the equipment to be installed. However, were I to suggest this, Mr. Bacon would probably remind me of a plant which I designed comparatively recently where the generator field rheostat equipment was brought in through the window after removal of several sashes.

I would like to ask the operating men present whether they have had experience with the bus structure compound Zellite absorbing oil which has been spattered upon it during the filling of oil switches and whether this weakens the compound.

One of the gentlemen inquired the methods used to prevent sweating of steel beams. There has been at least one case where ground cork paint, or paint which includes a grated cork, was used successfully. This paint is such as is used on steam turbine condensers.

In the installation and use of constant current transformers there is one point not generally considered, but which I understand has caused several failures. This is the action of these transformers while carrying fractional loads. Under fractional load conditions, the transformers are said to take excessive magnetizing currents which may overheat and burn out the primary. Have any of the operating men had such experience?

J. A. Northwood: I just want to say I am mighty glad to be here with you fellows and to hear this splendid paper. It has given me a big inspiration. We are getting down to the source of things in our safety game when we get at the design; that is the place to start safety, and the value of human life is worth while. One of the biggest problems we have in our safety game is in dealing with men and teaching men to think right, and a paper of this kind shows that there has been a great deal of thought given to it.

It is worth while to do a great deal of right thinking in the designing of work, particularly in our electrical line.

V. R. Bacon: Mr. Burr inquired about sweat proof roofs. We have, in the past, built up very satisfactory roofs by laying a concrete slab or pad, followed by a few inches of gypsum. This in turn was followed by a thin layer of concrete to protect the gypsum, and the roof finished with paper, tar and gravel. So far as I know, no difficulties have been experienced with roofs so constructed.

I think Mr. Burr, also, asked concerning standards for tripping voltages for electrically operated equipment. If I am not mistaken, this is specifically covered in the A. I. E. E. Standards at present.

Mr. Fuller spoke of additions to equipment. This point was covered in the paper but not discussed. Since Mr. Fuller has spoken of it, I believe it should be amplified some at this time. It is not infrequent that an industrial consumer may find need for additional power and that the power company will meet this need by the installation of more feeders. These additional feeders will almost invariably mean a considerable increase in short circuit current available and the customer's switching equipment will be severely overtaxed in the event of short circuits on his system. It is, therefore, advisable to always check the rupturing capacities of old equipment against new supplies.

In answer to Mr. Bye's question, I believe that the general condition is much worse than he outlined. On many of the manually operated breakers we have only a cover plate with no further protection to the operator. It is my belief that, as far as safety is concerned in this connection, the value of the voltage is rather a minor proposition. If a switch explodes, the oil fire will probably be equally destructive for all voltages. In the case of solenoid equipment, particularly in the outdoor types, the operator has no protection whatever when using the emergency operating handle. As a matter of fact, he may have his feet braced against the bottom of the tank to enable him to exert a little more force on the lever.

A. I. & S. E. E. Meeting

YOUNGSTOWN DISTRICT

ALL DAY SESSION

FRIDAY, FEBRUARY 7, 1930

"COMPARATIVE VALUES OF FUELS IN STEEL MILLS"
By H. V. FLAGG, Comb. Engr., American Rolling Mill Co., Middletown, Ohio

"THE SUBJECT OF NITRIDING"
By BRUCE CROWE, Metallurgical Dept., Carnegie Steel Co., Munhall, Pa.

"COMPARATIVE METHODS OF FLOW INSTRUMENTS IN CONNECTION WITH COKE OVEN GAS"
By J. M. SPITZGLASS, Republic Flow Meters Co., Chicago, Ill.

"GROUP VS. INDIVIDUAL DRIVEN ROLLING MILL STANDS"
By R. H. ELLIS, United Engineering & Foundry Co., Pittsburgh, Pa.

The Combustion of Liquid Fuel *

By ROBERT C. VROOM†

and

Economizers *

By W. F. KEENAN, JR.‡

Discussion

Discussed by

W. N. Flanagan, Special Engineer, Carnegie Steel Company, Pittsburgh, Pa.
J. F. Shadgen, Smoot Engineering Corporation, New York, N. Y.
F. E. Leahy, Fuel Engineer, Youngstown Sheet & Tube Co., Youngstown, O.
D. D. Pendleton, Pittsburgh, Pa.
Charles Blyer, National Tube Company, Lorain, Ohio.
R. S. Coulter, Combustion Engineer, Bethlehem Steel Company, Sparrows Point, Md.
Walter Sennhauser, Dry Quenching Equipment Corporation, New York, N. Y.
H. V. Flagg, Fuel Engineer, American Rolling Mills Company, Middletown, O.
J. L. Miller, Steam Engineer, Carnegie Steel Company, Youngstown, O.

R. C. Vroom: I would like to ask if in the higher pressures that are now being used, up to 1400 pounds, the amount of dissolved oxygen has to be decreased beyond that allowable at lower pressure.

W. F. Keenan, Jr.: I cannot give you a conclusive answer to that question because in all such plants every possible precaution is taken to minimize oxygen content of water entering economizer or boiler, and no experience is available in high pressure plants of that character except with practically perfect feed water conditions.

W. N. Flanagan: In line with that, Mr. Keenan, I understand you have made a lot of experiments, that is, determining a point at which you could take ordinary water and run it through the economizers and not get corrosion, as to velocity, without the regular precautions in reducing the oxygen content to avoid corrosion.

W. F. Keenan, Jr.: A series of such tests were made in France that seemed to prove that a high velocity reduced corrosive characteristics of oxygen carrying water. In trying to apply this theory in practice it has not worked out and it is now generally conceded that for satisfactory maintenance of steel tube economizer elements straight water must be slightly alkaline and contain not over .2 to .3 C. C. of oxygen per litre.

W. N. Flanagan: I started some experiments and it did not take very long to show that it wasn't high enough velocity to prevent the corrosion, and as it was necessary to do other work, we passed them by, but it showed that you have to go to quite high velocity.

W. F. Keenan, Jr.: It is probably so high you would never hit it in normal economizer installation.

Referring to remarks by one of the previous speakers on the corrosion of integral economizers. I believe that such corrosion is due to the fact that in integral economizers there is usually recirculation and a sluggish flow of water, which results in the formation of gas pockets at certain points where corrosion occurs, because the oxygen is higher than the average in the feed water. In positive velocity economizers there is no recirculation and it is never necessary to contend in any part of the economizer with higher oxygen content than the average in feed water as it comes to the economizer.

J. F. Shadgen: The applications of combustion have often local color and the utilization of equipment such as economizers may not be advisable under certain conditions. I learned yesterday a very interesting story in Detroit from a friend returning from Saskatchewan where he put into operation, a modern boiler plant under very severe conditions. During the last winter season, the operators were compelled to stop the boilers in order to chop the ice out of the stack. The outside temperature was varying between 40° and 60° below zero and the moisture content of the flue gases was being frozen at one point in the stack. It required a few days of chopping the ice to get the full area of the stack cleared up to permit the flue gases to pass to the atmosphere.

Considering the present heat wave, this seems to me a very cheerful experience. It proves that the local conditions are a great factor in the choice of the proper equipment. This boiler plant was operated without air preheater and without economizer.

W. N. Flanagan: There is one thing we have noticed from the pictures. Mr. Keenan showed the great difference in size between the modern economizer and some of the old ones. However, while we are on the subject of oil burning, has anyone anything to say in regard to either your experiences or troubles in using liquid fuel in furnaces and under boilers? In applying the mechanical atomization burner to a furnace like an open hearth pretty good direction of flame would be required. Has one ever been successfully installed in open hearth practice?

F. E. Leahy: You made a statement that I

†Peabody Engineering Company, New York, N. Y.
‡Consulting Engineer, Foster Wheeler Corporation, New York, N. Y.
*Presented at Annual Convention of A. I. & S. E. E., June, 1929, Pittsburgh, Pa.

thought you might open up a little, in which you said that the analyses of producers have shown that blast furnace gas is a far better heating fuel than as a metallurgical fuel. In some other places it is worth twice as much for metallurgical purposes even when enrichment is required.

W. N. Flanagan: Primarily they had in mind several plants that are operating, or have installed, pretty high grade boilers, but have small groups of high cost producers, serving for instance reheating furnaces, where due to scattered locations, a very high gasification cost is involved. In a case like that it begins to approach the value of coal plus the gasification cost against burning the coal into the boilers. In that case the gas producer is much higher than it is in the case of the boiler.

Of course, if you use the blast furnace gas in the boiler, it is only worth the equivalent price of coal plus the difference in the other costs between the gas fired boilers and the coal fired boilers. This difference is seldom more than $1.00 per equivalent ton and in most cases runs something like half that amount, whereas the gasification cost in some old producer plants runs $3.00 and $3.50 and perhaps more per ton of coal gasified.

I think I qualified the foregoing comparison. When I was reading the report I indicated that it probably ought to be qualified by saying that the value of Blast Furnace gas as a metallurgical fuel would not stand out nearly so vividly in comparison with a brand new producer installation, of sufficient size that the unit labor cost is low.

I wonder if one of Mr. Keenan's colleagues has anything to say.

D. D. Pendleton: Ask Mr. Blyer, of the National Tube Company, to say something.

Charles Blyer: I don't know that I can say very much, except that our results at Lorain would verify Mr. Keenan's statement about corrosion.

I was rather surprised to hear Mr. Keenan's mention .2 to .3 cubic centimeter per liter oxygen contents. We have noticed this to be the case. We have the Foster economizer at Lorain and we are not having any trouble, whereas we did have trouble with the lower velocity integral economizers.

F. E. Leahy: Mr. Vroom mentioned about the means for holding the velocity of the oil constant. I think we would all be interested in hearing just what regulation they provide in order to keep their oil in the best condition for use on the particular furnace, because I think many installations have a lot of grief, not so much on account of the burner used, but on the preparation of the liquid fuel up to the burner.

R. C. Vroom: Of course, ordinarily each particular fuel being used must be sampled in the laboratory, and the proper temperature obtained to which it should be heated to give the desired viscosity for any particular type of burner. For some time the company with which I am connected has been developing an instrument which operates on the theory that the pressure drop through a tube or slot of finite length will vary with the viscosity and that under our operating instructions this drop is independent the density of the fluid. While we have not entirely completed our experiments it has been found that through a very wide range of fuel types, this instrument will maintain the proper viscosity regardless of the temperature to which the fluid must be heated to give that viscosity.

The impulse element is the pressure drop which is obtained by means of an orifice or coil, or something of that sort. This impulse operates a steam pilot valve, and that in turn operates the main steam valve at the fuel oil heaters.

Walter N. Flanagan: There is one other item in regard to the mechanical atomization burner, do you find you have to centrifuge or otherwise clean the oil in general for mechanical burners.

R. C. Vroom: Ordinarily the auxiliary equipment for mechanical burners includes straining equipment, i. e., a strainer in the suction line having mesh opening about 3/16 of an inch in diameter, and a strainer in the discharge line having mesh openings about 1/32 of an inch in diameter. There are some mechanical burners equipped with an individual strainer having a mesh that is considerably finer. However, Mr. Peabody did a considerable amount of experimenting and found that often those individual strainers would clog up before the burner tip itself and he abandoned them as a result of that experimenting.

At one plant the sample of the Dubb's fuel which we have burned had an A.P.I. gravity of 7, contained 30 per cent of base settlings and water, and about 5 per cent of solid matter by extraction. There are absolutely no discharge strainers in the line. In another plant we are burning a mixture of gas, oil and the scrapings from Holmes-Manley oil cracking units. This fuel contains a large amount of rather large particles of solid matter in suspension, and there we have found it necessary to use for the discharge strainer an area equivalent to about ten times the pipe line area instead of an area from two to four times, which is ordinarily employed. If the oil is kept circulating through the burner tip which permits the use of somewhat larger passages, and keeps the tip cool, there is no reason why a mechanical burner can't handle a considerable amount of solid matter. Also in certain cases we have burned fuel containing up to 30 per cent of water; so there is really no need of centrifuging.

R. S. Coulter: In connection with the dry quenching of coke, I would like to ask a question What is the net saving by virtue of the dry quench ing and also is there any reduction in size of the product over the wet quenching.

Walter Sennhauser: At Rochester, the net saving of last year amounted to about 24 per cent of the capital invested. The Rochester Gas Company pays 50c per thousand pounds of steam if they buy it. In the dry quencher, they produce steam at about 20c per thousand pounds. During the first four months of this year the net saving was somewhat less. It depends, of course, entirely on the running periods, on how often they must shut down to inspect the plant, but according to the figures of last year, they had a net saving of about 24 per cent.

The dry quenched coke is somewhat smaller in size, but it is more uniform in size and it is much stronger.

In Rochester, I might say, the conditions are especially unfavorable as to the coke handling, because the chutes are too steep, and, therefore, the velocity of the coke leaving the container is too high. That breaks the coke up to a certain extent. At the new

plant which is going up now at Flint, we are going to try to eliminate all those disadvantages by using chutes with lower inclination, eliminating strong restrictions; but I do think that the dry quenched coke will be somewhat smaller in size. The big pieces will break off, but the fuel will be of more uniform size and there is no appreciable increase of breeze. At least, two years' experience at Rochester show that after the coke has passed the crusher—they sell all coke for domestic purposes—there is no more breeze than with wet quenching, and they claim that one particular advantage of that fuel is that the breeze, the fine dust, falls off the pieces so that they are able to produce a very much cleaner coke which is much liked for domestic use.

R. S. Coulter: Is the coke product from the dry quencher satisfactory for blast furnace operation?

Walter Sennhauser: Unfortunately, in this country, there is no plant running in connection with the blast furnace, but there are three plants running in Germany, in Czechoslavokia, and in France, and there they like the dry quenched coke very much, although it is somewhat smaller in size. The pieces that go into the furnace are very strong. They are able to get a very clean fuel bed and to this feature, they ascribe their saving.

They do not say exactly how much the saving is. I think it is very hard to find out anyway, because there are so many factors to be considered; but they say, that especially in this plant, it is the uniform size of the fuel which accounts for their saving.

R. S. Coulter: How much smaller would you say the size was, 15 per cent smaller than the regular wet quenched product?

Walter Sennhauser: I would say that the big pieces are about 3 to 4". Their proportion may be reduced—it is hard to say how much, but perhaps as much as 60 per cent, but the proportion of the medium size coke stays about the same. The big pieces especially are broken up going through the coke container, but there is not so much change in the smaller pieces.

H. V. Flagg: Now in regards to the paper on fuel oil—I am interested in fuel oil more with respect to the application to small furnace burners which burn from 2 to 5 gallons an hour. We have had some rather trying experiences with the burning of heavy residues—around 14 gravity with viscosity considerably higher than that mentioned in the article. Several difficulties have come up such as oil dropping out in the furnace when the atomization was not thorough and before combustion was complete, carbon deposits formed on the furnace walls, plugged up burners, screens, controls, and so on. One thing that wasn't discussed in the paper and seems to me to be worth some consideration, is the design of the port through which the gases pass from the burner into the furnace, and the materials from which the port blocks are made. I think that the port design plays a very important part in the combustion of fuel oil in a small furnace.

Another thing about the oil cracking residues that are being used at present that should be kept in mind is the limitation of temperature that must be observed to prevent the settling out of free carbon in the tank and circulating system. The free carbon content in these oils is high but remains in suspension well at low temperatures. If the temperature is kept too high this suspension is lost and the solids settle out. The question is what temperature can be carried? There is also a question as to what to do with the sludge deposits that build up in the tank to avoid the disagreeable task of cleaning tanks and also the heavy loss of fuel involved. I would like to hear of the experiences of other men with this problem.

J. L. Miller: Does the carbon particles that you speak of hang in suspension in the oil. Have you ever noticed any difference in the ash content and the carry over into the stack.

R. C. Vroom: Of course, as I said in the beginning, all of our experience has been with boiler work, but we didn't notice any appreciable effect on the atomization. As far as the settling of the solid matter in the tank is concerned, there often are pumps at the tank and these take the oil out radially and return it tangentially, so that the oil body in the tank is kept in constant circulation to prevent the sludge from settling.

I think there is no question but that in a heat-treating furnace, the arrangement of the ports leading to the product being heated has a very considerable influence on the results which will be obtained with dirty fuels, but on that particular point I haven't any definite information available.

I have had no report in regard to a deposit of ash from these carbon particles in a boiler furnace, although that wouldn't be so important if it did occur.

W. N. Flanagan: In regard to the use of gas, as Mr. Flagg mentioned, particularly in the open hearth furnaces, there is still—I don't know whether Mr. Leahy will bear me out on this or not—to my mind a great uncertainty as to whether we use the gas that is available and the pressure that is available to the fullest extent.

For instance, in the case of coke oven gas which has not been previously purified from sulphur. To avoid adding sulphur to the bath, a burner arrangement is generally used which is designed solely with the idea of obtaining early combustion.

On the other hand, it results in throwing away the greater part of the pressure that is available to produce the driving force and to direct the flame over the bath. In other words, in most of the coke oven gas-fired furnaces there are two opposed pipes in each port through which the gas enters and loses most of its pressure and velocity, finally leaving the port at about the same speed in a conventional producer gas furnace.

The same thing applies to many natural gas furnaces which throw away practically all of the pressure that is available for obtaining direction and driving force, to keep the flame away from the roof and walls. There still seems to be room for considerable improvement in the method of burning gas to obtain not only early combustion as desired but also direction and driving force which has made liquid fuel so desirable as an open hearth fuel.

In regard to the question of sediment in the fuel oil, it is something like that encountered in burning tar, which contains lot of coke dust. The general practice around most steel works is to let the stuff settle, out in the storage tanks, when it gets too high, to get in and clean it out, and burn is over

the hillside or where feasible mixed with boiler fuel. It isn't a very scientific way of attacking the problem, but it keeps the coke out of the burners, and eliminates a lot of strainer cleaning.

Some of the smaller burners, such as those on heating furnaces—particularly if using a high tar pressure such as many plants do—get down to pretty small burner openings, and it doesn't take a very big piece of coke to stop the burner completely. This is the main reason of the proponents of the low pressure burner since it involves much larger openings. However, in the open hearth most plants seem to prefer the high pressure burner on account of its driving power and also because the atomizer may be kept out of the furnace and the tar-steam mixture delivered into the port through a water cooled tube.

J. F. Shadgren: The majority of operators seem to be inclined to play with control and want to develop partial solution of the problem. Now, it is well recognized that the combustion problem is rather complex and that a partial solution does not give real satisfaction. The experience in boiler rooms has proven that point conclusively.

Some twenty years ago, one element was alone controlled at the boilers while today all the elements are under the mechanical operation of the regulators. This has proven to be economical and it is safe to say that the same experience will be repeated in modern metallurgical furnaces. The great hesitation shown by operators to go into the control problems thoroughly is being overcome due to the accumulated experience of the past years on trial installations in several plants.

The writer has knowledge of one plant where the management appropriated some $10,000 for a control application on an open hearth furnace. This installation will require at least three regulators to be co-ordinated by a Master Controller. The regulators will operate on the volume principle, measuring the volume of the gas, airs, or flue gases as the case may be. After the regulators have been tuned up, the question of distribution of flame during the melting period and the control of the flame during the refining period will have to be tackled and solved.

I have discussed the problem with Mr. Leahy in Youngstown and we reached the conclusion that the control is very desirable. Of course, before any work can be undertaken, appropriations must be made available to start the co-operative work between the operators and the manufacturers of equipment.

I want to say in conclusion that the manufacturers are ready for these experiments and that it is up to the steel plants to take advantage of the experience accumulated in other fields and to adapt proven equipment to the operating conditions of their furnaces.

W. N. Flanagan: In connection with Mr. Keenan's paper, there should be several here that have problems involving economizers and blast furnace gas. That is why I regret that Mr. Cutler left. He has one of the installations of combined air heaters and economizers, from which he reports such good results that none of the rest of us believe him, but he evidently is doing very well.

Has anyone else any similar problems? Have you anything more to say Mr. Keenan?

W. F. Keenan, Jr.: I don't believe so.

W. N. Flanagan: Mr. Vroom?

R. C. Vroom: I don't believe so.

W. N. Flanagan: Has anyone else any remarks? If not, I think we can have the meeting adjourned. I certainly appreciate the help that you gentlemen have afforded me with the discussion.

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*Steam Generation and Utilization**

By L. C. EDGAR†

Discussion

Discussed by

W. B. Skinkle, Engineer, Pittsburgh District Power Committee, Subsidiary Companies of U. S. Steel Corporation, Pittsburgh, Pa.

W. N. Flanagan, Special Engineer, Carnegie Steel Company, Pittsburgh, Pa.

F. E. Leahy, Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, O.

T. J. McLoughlin, Fuel Engineer, Carnegie Steel Company, Duquesne, Pa.

M. J. Conway, Fuel Engineer, Lukens Steel Company, Coatesville, Pa.

F. G. Cutler, Chief of Steam Engineering Dept., Tennessee Coal, Iron & Railroad Company, Ensley, Ala.

Harry Cronemeyer, Combustion Engineer, Jones & Laughlin Steel Corp., Aliquippa, Pa.

W. B. Skinkle: Mr. Edgar's paper is very timely and has brought out a number of valuable points. Not being an operating man myself, I am afraid I cannot add very much to it with any remarks which I would make.

I have made a good many surveys of power conditions in Steel Works for the purpose of determining what economies were possible and attempting to point out what general procedure should be followed in future programs.

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†Chief Engineer, Carnegie Steel Company, Edgar Thomson Works, Braddock, Pa.

*Presented at Annual Convention of A. I. & S. E. E., June, 1929, Pittsburgh, Pa.

One of the questions which I have found most bothersome is that of determining the "Lost and Unaccounted for" steam. I have found that it often happens that the fellow who has the poorest boiler plant and smallest organization of testing engineers can generally account for about 95% of the steam he says he generates, whereas the fellow who has a high grade department of steam engineers often has trouble in accounting for more than 70% of the total steam produced. I am often tempted to believe that the first mentioned group works a good bit of what we often call "pencil chemistry" in forcing a balance, while with the second group it is almost obvious that they are reporting just what they find in their steam balance.

I had occasion at one time to make some extensive studies of a large steel works outside of Pittsburgh, in which it appeared that there was fuel burned for much more steam than was apparently used. The possible economies seemed to be disproportionately large.

In order to get test data with which to check these apparently large economies, a large number of steam meters was needed. The plant started out by installing 40 meters at strategic points expecting to leave the meters in their original locations for a year while data on steam distribution was accumulated. At the end of that time new locations were picked out and the experimental department asked for the removal of the meters to their new locations. You should have heard the "howl" from the operating men. There was simply "nothing doing" on moving a single one of those meters and when the "smoke"cleared away, it was found necessary to order 42 or 43 more meters before a complete check-up on the steam balance was possible.

The results of the installation of these meters has been very beneficial. Losses were located and stopped. A boiler house large enough to consume all available blast furnace gas was built and two coal-fired houses were ultimately taken out of service.

Walter N. Flanagan: One thing that is uppermost in my mind at the present time regarding steam generation and the utilization, is the fact, as Mr. Edgar brought out so forcibly, that the boilerhouse which is modern or super-modern today, is liable to be obsolete next year. I don't think there has ever been a period in the history of steam generation that this has been so true, because of increasing utilization of higher pressures, rapid developments in combustion equipment, and in auxiliaries. In fact, everything from size of units to details of construction is very rapidly improving and changing.

This leads up to the fact that a large burden is placed upon the operator, because it is not always feasible after you have made the initial investment in what is a modern boilerhouse today, in four or five years to justify the removal of that boilerhouse and the substitution of a still fancier one; so it is up to the operator to make that equipment which is installed today, or was installed five years ago, by careful operation, keep step in commercial economy with the new.

In steel works though, the steam lines have been blamed as the biggest source of trouble and inefficiency I think this has been brought out several times before, but it is well worth consideration. There are often too many supposedly temporary and small consumers tied into all of the steam lines. Little heaters here and there, shanties heated by steam coils, steam used for thawing, and countless other uses usually supplied by long branch lines.

Now, if we had the same amount of small more or less necessary or unnecessary equipment hooked onto our electric lines, the electric lines would be very inefficient. One large electrically operated mill began to notice this tendency. Usually all of the steam heaters are left on twenty-four hours of the day, and practically nine months of the year, you can readily realize what would happen in the electrical lines if they were treated the same as the steam lines have been.

Of course, some steam lines have been, in a way, utilized partially as a safety measure. For instance, a good many of those shanties the fire underwriters will not permit to be heated in any way than by steam or electrical heaters.

But when you take the main steam lines as a unit by themselves, they are usually very efficient in our average plant. Particularly in the last few years most of the plants have seen to it that their main lines are very well covered and very well taken care of.

In the average industrial plant, and particularly in a steel works, the study that offers probably the greatest increase in overall steam plant efficiency is that of bringing the output of the boilers down to as close as possible the net consumption of the producing units of the plant.

F. E. Leahy: I am sorry that I arrived a little too late to hear the first part of that paper. The subject is a very live and interesting one at the present time. One of the rather strange things that has come with the increased interest in economy is the demand for decreased use of the steam.

When we were developing steam all over the place and paying little or not attention to the cost, pipe-fitters were willing to connect up with any system that they thought would like to have the use of additional steam, but today everybody is busy trying to find out how they can eliminate the use of it. The waste elimination campaign is probably responsible for this. Within the past year, the concentration of attention toward waste elimination methods has brought out a lot of practices that were not considered to affect the cost to any considerable degree.

Mr. Flanagan mentioned the very active point of attack at the present time, in the elimination of heating, and replacing with more or less direct methods of heating. Even electrically heated small shanties have been found in many cases to be more economical than steam-heated, and each point of use for heating has been studied with a little care and attention as to which would be the most economical way to do it, and in many cases buildings requiring a very small steam-load located quite a distance from the steam plant have been cut off, and small, direct fire-systems that have been installed, have made quite an appreciable return.

This movement seems to be going on all around the country. I have had an opportunity to visit a number of plants, and I found the same attention to reducing the steam generating load, particularly eliminating the steam heating, and in many cases

the returns they have shown have been quite remarkable.

I am sorry I didn't hear the first part of the paper. I was wondering whether Mr. Edgar mentioned anything about the cleaning of blast furnace gas. I notice that in some of the new boiler plants recently installed, they have not put in any primary cleaning system for gas, whereas it is used on boilers, and in our own case we have installed a cleaning system, and now that we have it, we are commencing to wonder whether that is the best way to do it. It is rather interesting to learn whether Mr. Edgar touched on that.

T. J. McLoughlin: There is one point that occurs to me in connection with the more economical use of steam in the modern steel plant. In every such plant there are numerous small buildings, offices, tool rooms, etc., to which live steam lines are constructed for heating purposes alone. Often these lines are quite long and their maintenance given little or no attention. In many cases the heating systems are connected to traps which are located in pits and other equally inaccesible places and receive no attention whatever with the result that traps often get out of order and live steam blows through into the sewer. Due to intensive competition and the necessity for eliminating waste in order to reduce production costs to a minimum the economies that can be effected by more careful design, concentration and more judicious location of auxiliary buildings are now receiving considerable attention in the steel industry.

M. J. Conway: Thank you, Mr. McLoughlin. Does anyone else wish to add anything to this discussion? Mr. Leahy's question is still unanswered. Perhaps some one can answer it from the floor.

F. G. Cutler: With reference to the point that Mr. Leahy has brought up, I would say that the Tennessee Company about a year ago started a new boiler plant, in which the gas cleaning is done by Cottrell electric cleaners. In this cleaning plant the preference is given the stoves, that is, the velocity through the cleaner is reduced in the units that supply gas to the stoves, and the surplus goes to the boilers. As a result the boilers get at times fairly dirty gas.

My recollection of those records is that we probably get an average, well from one-half grain to a grain and a half. At times it goes up a good deal higher. The boilers are equipped with air heaters, economizers, with a Bailey floor on the bottom of the furnace, and a row of bare tubes on the front wall. Outside of a little deposit in the superheater tubes, which required rearrangement of the soot blowers, the results have been very successful. We have run the boilers for a considerable period without having to take them off on account of any trouble. The air heaters, so far as I know, haven't been touched or even inspected. There is no indication of any stoppage in those. There has been a slight accumulation on the side walls, a feather-like deposit which comes from the blast furnace gas.

Along the lines of Mr. Edgar's paper, I recall one thing that was done at one of our plants in the reduction of waste which was outstanding in results: We had a barometric condenser we used to run these long cross-head type of blowing engines. We instituted a system of checking steam consumption of the blowers, and we interested the master mechanic in this. We showed him each day how much steam was used by the blowing engines, and by checking back on the blast pressure, we were able to get the approximate horsepower required, and we told him each day the amount of steam per horsepower he was using on his blowing equipment.

Well, he commenced a campaign of reboring cylinders, fixing up packing rings, fixing up his air tubes and the result was a very appreciable improvement and it required very little labor, and the results were very satisfactory.

M. J. Conway: Thank you, Mr. Cutler.

It seems to me that one of the large losses in a steel plant boilerhouse is due to the fluctuation of the steam plant load, the rolling mill load. Has anyone here had any experience with an accumulator in a steel plant? Mr. Flanagan, have you anything to add?

Walter N. Flanagan: I would like to hear somebody else's opinion in regard to that matter of accumulator. I made some rough calculations along that line, and it generally showed that if you were working within a very close pressure range, it took an enormous accumulator to do any good. The accumulators that I have seen work—aside from those in connection with low pressure turbines, are working through quite a pressure range, probably from 50 to 100 pounds. That is too much for most steelworks, where we want to use them on mill engines. They might be used to advantage where it is desired to bleed from a particular high pressure boiler house into say 150 lb. lines.

M. J. Conway: Anyone else? Mr. Cronemeyer?

Henry Cronemeyer: I have been out of the operating end for quite some time. I am back in the designing end and am not in touch with the operating end.

L. C. Edgar: Perhaps he could tell us something about good designing. You know good designing is just as important. Sometimes we emphasize design too much, and sometimes we emphasize economies too much, that is, economies we can make. We look at the stars and forget the ground under our feet; but then we have to look at the stars, too, you know. We have to consider improved and modern designs.

Henry Cronemeyer: I am just now making some investigations, and I haven't anything concrete to offer. In the steel plant practice, I think we are in somewhat of a different position than are the public utilities plants. I think we all realize that the public utility plant will go to great length to save even a fraction of a per cent in operating economies. In the steel plant, however, our objective is to produce steel as cheaply as possible, and power generation is only incidental to the main purpose. A given expenditure may yield better returns when spent for improving steel making, than for capturing the last B.T.U., so we can do better by sticking to simpler design, without, however, losing sight of new developments in power plant practice.

However, it is becoming quite the practice in steel plants to go to higher pressures, as Mr. Edgar just mentioned, and also to go to much larger units.

When the association visits the Jones & Laughlin plant, they will see some large boilers, with combustion chambers almost large enough to hold the boilers that we built when I first got into the game.

L. C. Edgar: This question of line is one that is very pertinent. I have been through a campaign or two on this line question. The last one was a very vigorous proposition, and we cut off a good many lines that our operating people felt shouldn't have been cut off, especially heating units and places where they felt that they ought to have facilities for keeping warm in the winter time, but regardless of that, in many cases when we investigated we found that some of these shanties—we call them shanties, but they were labor quarters of various kinds—weren't very well located in the beginning, and by a little care and consolidation we could eliminate a number of these places, which was not only a saving in steam but it was a saving in men, and brought the men units out into the light of day in many cases, and resulted in a satisfactory economy for other reasons.

That study of steam lines was part of a study for relocation of quarters for headquarters for various gangs, and I think, if I remember correctly, that we eliminated almost 100, or perhaps a few more than 100 small buildings. The new quarters were put on the roads, and they were put convenient to their superintendents. They were brought out into the light of day so that you could see what was going on, and it resulted in a considerable saving of labor, and in that way there were a lot of lines that weren't necessary. In this campaign we virtually eliminated miles of line. Now that includes, of course, little lines and big lines. There were not so many big lines, and it was all in the interest of economy, and I can say that there has been a very substantial reduction in the steam losses from that campaign. They were actually noticeable on our distribution.

Mr. Skinkle says we don't know where 33 per cent goes. I believe we know a little closer than that, and it was absolutely noticeable when the lines began to be cut off.

Then there were steam syphons that ran pretty nearly all the time, and we replaced them with electric pumps for control. For a few hundred dollars you can get a pump that will pay for itself. As you know a syphon uses a tremendous amount of steam. If you want to get water lifted that way, you can easily spend $3,000.00 or $4,000.00 a year on a syphon; so that you want to be critical of any steam syphon that is running as a regular thing.

Then, of course, the traps come in for their share of the criticism.

Now, it is well enough to carry on a campaign of that kind, but after you have carried it on, if you just leave it alone, it is going to go back again. I believe rather firmly in the concentration of authority for the installation of steam lines. At the Edgar Thomson Plant the General Superintendent has said that there will be no lines put in for any purpose whatsoever that do not have the approval of the Engineering Department, and we are not very generous without allottment of lines. There has to be pretty good cause shown before a line will be put in, and any temporary lines that are put in, must be removed. Many times a temporary line is put in and it is forgotten to remove it, and those must be kept track of. So I think the concentration of authority in that matter is quite an important thing, and I feel that the engineering department is a good place for that authority to be, because it keeps the engineering department alert to the economies that can accrue from the elimination of unnecessary lines, and also it guides them in the design of new lines. In order words, it keeps them in touch with the situation. You can't be in touch with something that you know nothing about.

Now, another thing is accurate distribution. I have always been more or less of a crank on accurate distribution. I don't mean to claim that ours is any more accurate than many others, but I do feel that accurate distribution is an important thing, and that, regardless of where the chips may fall, let us make the chips, and put the steam distribution down exactly where it goes, and not try to favor anybody, but get the exact facts, and I have always made that a rule with our steam engineering department. I have told them repeatedly that we must have the facts accurately, that otherwise they are no guide at all, and we might by leaning one way, or leaning the other way, make one department show a little better, or we might make another show a little poorer and still be in the range of honesty, but showing a little favoritism. All of you steam engineers know how that is done. I feel that the thing is to get them as accurately as we can in an unbiased way, so we know what is going on, and we know where we are and can be guided by that information.

And then another economy that can be made—this is a big thing—is a rather continuous supervision of vacuum. That comes, in our case, under the steam engineering department work. They have to check from time to time, and we sometimes feel, Well, here's an old unit, an old condenser, an old engine, and the vacuum is no good anyway, and we won't have anything to talk about, or that we can't stand up in the meeting and tell how high the vacuum was, nevertheless we can make a tremendous saving even though the vacuum isn't high.

If you get it up as high as it can go, you have accomplished something, and many times you will make more substantial savings by that sort of supervision than you will by some of the better units, because they are naturally better supervised. It is these old units that eat up the steam, I have found, and the new and better units usually will have a tendency to take care of themselves because they have better supervision. So I would say, watch out for the old fellow, watch out for these old-fashioned things that eat up steam—the old engine, the old condenser, and the old lines, and the things that have been there and are sort of rooted and grounded in our system, and we take them as a matter of course, and we say that we can't do anything about it, and that unless we get a lot of money we can't make any saving, but we can make a lot of saving lots of times on these old units, the old steam engine, and the old condenser, and the old boiler, and sometimes we can make them much better with no investment expense.

I don't believe that it is any credit, or that it is going to help us any in getting new equipment to run the old units in a slipshod manner.

Now, concerning the question of dirty gas, there is, of course, some difference of opinion relative to clean and dirty gas, and some hold that with the clean gas you lose a lot of the heat, and if you put it in with dirty gas you get the benefit of that heat, and that it pays for cleaning the tubes and blowing the dust off, and all that sort of thing. That may be a debatable question. I haven't calculated recently, and I wouldn't want to speak with authority on just how that balance would work out, but personally I am for clean gas for another reason also, and that is that you save the ore that is in the gas, and that is a considerable item. If you have a cleaning facility at your furnace and near your furnace, you can get quite a considerable return, and I think the losses at your blast furnace probably would pay for cleaning the gas and would more than make up the difference in the heat.

Of course, there is another way of doing that, as they have done out at Massillon, and that is also a debatable question, and I have never worked out any balance on it, but, of course, a good many of you now have the unit which reheats the gas after it is washed; so that there are a lot of ramifications to that gas situation, and I think that it is a matter that each plant has to work out to a certain extent for itself.

As far as we are concerned at Edgar Thomson, we feel that we are going to try to get clean gas. There are three very good reasons for clean gas. One is that if you have gas washers at your plant, you trap a lot of dust which is a nuisance to the community, and it results in considerably improved living conditions in the vicinity of the plants. That has been accomplished to a large extent at the Carrie furnaces as a good many of you know, and it has cleaned up the community to a considerable degree, not that it is exactly a clean community, but it is much cleaner than it was. Then there is the question of the better operation of boilers, which is worth while, and lower maintenance, and the third thing is the question of trapping the dust that comes out with the gas and thereby increasing your furnace yield, which is probably one of the large items.

When you write all those items together and sum them up, it seems to me that we have a rather definite reason for clean gas. However, the next question after that is how to clean it, and that is another problem that we are not discussing this morning, but we could spend considerable time on it.

I believe that is all that I have to say this morning.

The next subject is one that is very interesting to all of us, and that is the question of boiler water conditioning. We all, in the efficiency of our boilers, and also of our turbines, find that satisfactory water conditioning is an important item. We hear a lot about water conditions from various sources. We have salesmen call upon us with all kinds of boiler compounds, and panaceas, and some of them are good, and some of them are not so good, and we get a lot of education on that matter from time to time, but I think we have with us this morning a man who is a real authority on this matter of water conditioning. He has given a lot of time to it, and it is beginning to be bibliography with most of us.

*Some Results of Water Boiler Conditioning**

By R. E. HALL†

Discussion

Discussed by

Harry L. Baer, Water Treatment Company of America, Pittsburgh, Pa.
F. E. Leahy, Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, O.
W. N. Flanagan, Special Engineer, Carnegie Steel Company, Pittsburgh, Pa.
L. G. Lehman, Pittsburgh, Pa.
T. G. Timby, McKeesport Tin Plate Company, McKeesport, Pa.

Harry L. Baer: There is only one question that comes to my mind. For a number of years I have been at this work of feed water conditioning and the old question of caustic embrittlement seems to be very much alive today. I would like to get some opinions here of just where this exists and what the conditions are today.

The point that is in my mind is high alkalinities as being somewhat the cause of this, and personally I have been in a good many boilerhouses, and worked with a good many engineers, and this doesn't seem to bob up in my experience very much, and it has been the one question that I haven't been able to get as much information on as I would like to.

F. E. Leahy: It is a very interesting paper, and although I am very much interested in the subject, outside of probably asking a question or two, there is nothing that I can add.

In this district to just what extent should the primary treatment be carried on in connection with secondary treatment within the boiler? I believe, from what I have been able to gather from Mr. Hall's address, that he recommends particularly the secondary treatment. Is there a balance between the primary and the secondary treatment that would make, under certain conditions, secondary treatment unnecessary and where should the secondary treatment start?

W. N. Flanagan: I would like to ask the au-

*Presented at Annual Convention of A. I. & S. E. E., June, 1929, Pittsburgh, Pa.

†Director, Hall Laboratories, Inc., Pittsburgh, Pa.

thority one question. Can you give us some measure of the labor expense required in controlling the condition of the water in the boilers. The cost of the chemicals can be readily calculated, but from one who has had experience, I would like to know about the extent of the labor involved in putting such a system into operation.

L. G. Lehman: In our association with some prominent insurance companies and obtaining of first-hand accident information, I think it is particularly proper to emphasize the extreme importance of Mr. Hall's subject.

An accident which occurred during the past year to a boiler drum from caustic embrittlement so attracted my attention to the cause of this embrittlement that special efforts were made to obtain up-to-date information,—which just happens to fit in with this meeting,—on what this embrittlement is, by what ways and means it can be overcome, and the danger of even a weak alkaline solution when deposits can concentrate whether by way of seepage into openings of seams and rivets or from lack of circulation. If there is time for this information, I would be glad to give it or possibly later present it.

News just came to us of an accident which occurred this past week, in which the loss reported is $150,000 and perhaps a few paragraphs which summarizes the study of some 300 embrittlement accidents in Bulletins Nos. 177 and 155 by Professors Parr and Straub of the University of Illinois (Urbana), would be in order.

T. G. Timby: Has it been definitely established that organic colloidal material will have no effect on the decomposition of soda ash under boiler conditions?

R. E. Hall: On the question of embrittlement, it looks as if it might occur anywhere. If Dr. D. J. McAdams of the Naval Experiment Station, Annapolis, is right in his summary of things, then the simultaneous action of stress, and especially cyclic stress with corrosion will be causative. The corrosion may be caused by the excessively high caustic in which the metal dissolves, or it may be caused by high chloride, or oxygen, or electrolytic action.

One of the troubles in embrittlement has been this, that the insurance inspectors in inspecting cases of boiler failure have had a tendency to say low water, and in years past have not been giving sufficient heed to the situation to really line up the cases of embrittlement. Thus it is a little difficult to say just where they have occurred, but as the present time, their distribution is very general. The thing that is so destructive in embrittlement is this: If one boiler in the plant goes, what right have you to believe that any other boiler is a safe proposition? The most exacting examination and testing are essential before any other boiler can be given a clean bill of health.

The cost of insurance against embrittlement, by following the rules recommended for its prevention is not high, and it seems to me that there is every reason for following these rules on prevention of embrittlement. From our standpoint of taking responsibility for other people's boilers, we have no recourse except to insist that everything be done so that we shall be following all of the best recommendations possible. If the boiler owner himself wishes to slack off on these, we then can take no responsibility for results.

Now where does secondary treatment with phosphate start? That question was asked. Somewhere above 150 pounds, and between 150 and 175 pounds.

The amount of soda ash that is necessary to maintain clean boilers, by its decomposition produces alkalinity that is in excess of the sulphate-alkalinity ratios for embrittlement; therefore where the decomposition of soda ash causes this too high causticity, then at that point you must begin secondary chemical control, and I would say with a lime soda softener not above 150 to 175 pounds.

With the Zeolite Softener, the bicarbonate in the softened water may be high or low, so that control with a secondary chemical may be essential at any pressure.

The labor expense of testing and the chemicals, for the secondary control is about $1.75 per million pounds of water following a lime-soda softener. On the zeolite softener dependent on the bicarbonate in the softened water, the control may be more or less, with a minimum of perhaps $1. In a row of six boilers, it is sufficient to test three of them each day, if the secondary chemical is applied to the feed water. To make the test on those boilers, once you are set up in good shape is, perhaps, half an hour's job. Half an hour to three-quarters of an hour will take care of the whole situation.

As regards the effect of organic material on the decomposition of soda ash, so far as we know, the decomposition of soda ash follows the ordinary physico-chemical laws of partial pressure, and the organic material cannot affect it.

A. I. & S. E. E. Meeting

PHILADELPHIA SECTION

N. C. BYE, Chairman — L. O. MORROW, Secretary

SATURDAY, JANUARY 4, 1930

"THE APPLICATION OF ELECTRIC MOTORS"
to
THE MANUFACTURE OF CAST IRON PIPE
by
GEO. PFEFFER, Chief Electrician, Florence Pipe Foundry and Machine Co., Florence, N. J.

WEDNESDAY, FEBRUARY 5, 1930

"FURNACES AND FUELS IN HEAT TREATMENT OF STEEL"
By W. O. RENKIN, Industrial Furnace Division, Combustion Engineering Corporation, New York, N. Y.

*Gas Producers**

By F. E. LEAHY†

Discussion

Discussed by

M. J. Conway, Fuel Engineer, Lukens Steel Company, Coatesville, Pa.
Chas. Longenecker, Pittsburgh, Pa.
F. G. Cutler, Chief of Steam Engineering Dept., Tennessee Coal, Iron & Railroad Company, Ensley, Ala.
H. V. Flagg, Fuel Engineer, American Rolling Mills Company, Middletown, Ohio.

M. J. Conway: The meeting is now open for discussion on Mr. Leahy's presentation. There are quite a few men here who know the gas producer problem, and we would like to have you come forward without being called upon.

F. G. Cutler: I would like to know the diameter of the producer.

F. E. Leahy: I think it is 10 feet 6 inches inside the lining.

Charles Longenecker: About what would your steam consumption be?

F. E. Leahy: The steam consumption on that producer would run from .235 to .3 of a pound of steam per pound of coal.

M. J. Conway: I see there are quite a few men here who know the gas producer practice thoroughly. This is a very important problem, as Mr. Leahy has pointed out. Has anyone here done any work on the sizing of coal, the amount of gas produced per square foot due to sizing? Have you, Mr. Leahy?

F. E. Leahy: No, I haven't. There is one feature of the operation that I would like to have some opinion on if anyone has had any experience along that line; and that is on the rate of gasification. We are getting on an average of 4,000 pounds up to 6,000 pounds of coal per hour; yet if we get the wrong grade of coal, we experience a lot of flue dust and clinkers, and although we have separators at the end of the producer, the amount we produce seems to be way out of proportion. We thought at different times that we should set a maximum rate of gasification, so much per square foot of area, so that a producer for say 6,000 pounds of coal per hour should be at least 12 feet in diameter, and if you want a higher output, the diameter should be increased to keep the gas velocity low, so as to maintain the amount of dust carried over at a minimum. I wonder if anyone has had any experience along that line, particularly on the amount of dust.

H. V. Flagg: On the question of dust formation, we have had some little experience with the same thing. We found that with low gasification rates we had less dust to contend with than we had at high rates, but I wonder if it was not because of the temperature of the producer as much as it was the velocity through the producer. For instance, on high gasification rates it was found difficult to hold the gas temperature down without having the fire build way up. If the fire is allowed to build up, the gas temperature can be kept down, but this leads to operating difficulties that are hard to handle. It follows that if the fire is kept at the same thickness for high rates as for low, the gas temperature will be increased which will crack the tar and increase the amount of dust made.

I was wondering on these tests if Mr. Leahy had ash fusion tests on these different coals to check up against the blast temperature necessary to keep the fire from clinkering. That seems to be a vital factor in the producer operation. The thing to aim for is to carry the fire at the bottom of the producer just as hot as possible without making clinkers, so that the ash fusion temperature is one of the limitations that we have to work under in producer operation. We are given a certain type of coal and we want to keep our hydrogen just as low as possible so that the least steam we can possibly use will give us the best producer operation we can hope for. If we can get by with 0.22 pounds steam per pound of coal, with the type of coal we are given, we are certainly going to make better gas than if we use 0.35 pounds steam per pound of coal.

I would like to raise the question of gas temperature. Some plants are using the off-take gas temperature as almost the determining feature in the control of producer operation. It seems to me that, given a coal of a given ash fusion point which will determine the quality of the blast or, the amount of steam that must be used to keep the fire right, and given the depth of fire that is the easiest to maintain in the producer at the required gasification rate, there will be a certain temperature resulting from those conditions. If the temperature in the hot zone of the producer is 2400 deg. F. and the thickness of the firebed is 30 inches, the gas coming off that producer will be at a certain temperature as long as those conditions are maintained. The only way the gas temperature can be lowered with that same coal is to increase the thickness of the firebed or increase the amount of steam used. On the new producers with the control of the blast temperatures, that is a comparatively simple proposition, but on the older types, with the old jet blowers we have no means of steam adjustment except by changing the nozzle diameter. Therefore it is necessary to set the nozzle diameter as close as possible according to the characteristics of the coal that is used.

I would like to hear this question discussed by other men who are working on producer problems.

As far as producer control instruments are concerned, I am wondering about Mr. Leahy's point that

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*Presented at Annual Convention of A. I. & S. E. E., June, 1929, Pittsburgh, Pa.

†Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

the regulator was a very desirable feature, with the possible exception of the open hearth? I am wondering if it isn't just as important in the open hearth as any place else, for this reason: With natural gas and fuel oil you have valve control that provides a positive adjustment of fuel supply without any variation at all to speak of, while in producer operation you haven't that control of pressure. The air will remain practically the same, but the fuel supply is at the mercy of the producer operation which lets the pressure go up and down the line over a range of a quarter inch, perhaps. It is a certainty that if gas is put through an orifice of a certain size, with .6 inch pressure at one moment and the next moment .4 inch, with the amount of air supply remaining the same, the combustion characteristics in the furnace are not going to remain the same. So from that standpoint it seems to me that the thing to do is to work towards uniform gas producer operation, and then put that gas into the furnace at a constant pressure, so that the gas producer pressure regulator has a very fine application in the open hearth furnace.

F. E. Leahy: Mr. Flagg has raised some very interesting points. I don't know whether I can answer them all.

About the gas temperature, the latest I have heard on the control from the gas temperature was in talking to Mr. Pritchett of the Republic Flow Meters Company. In the meeting the other day he told me they were controlling the operation of a producer, by regulating the feed of the coal from the gas temperature automatically.

Some years ago we put individual pyrometers on our gas producer in a plant where we were operating six regenerative type furnaces from one producer plant, and the operation was very satisfactory.

When we started the gas temperature was maintained at an average of 1400 degrees. This gave a gas satisfactory for welding practice, and later it was discovered the best welding practice was around 1550 degrees. I believe there is a great possibility for improving the gas producer operation by controlling the coal feed from the temperature of the gas produced. We always figured that if we held the gas temperature constant, we held the feed in direct proportion to the demand on the producer; so that our experience would amply justify any installation of pyrometers on a producer to control it so as to maintain a constant temperature.

Mr. Flagg also asked about ash fusion tests on these coals that we made the runs of. The tests were more or less of a commercial nature. The purchasing department was surrounded by a number of coal salesmen, who figured that we were paying too much money for coal we were using in regular operation, and they asked if we would run some test runs on these different coals of which they sent in so many carloads to try, and it didn't take very long in making observations—just standard observations, without any attempt to make very complete balances, to isolate most of the coals that were offered, particularly when we wished to operate the producer at the higher rates of gasification. We found that we couldn't use any coal. We had to limit our coals to obtain satisfactory operation.

Mr. Flagg also raised the question about the use of a regulator on a producer operating on open hearth furnaces. Our experience with the regulator on the open hearth furnace, or rather with the producer working on the open hearth furnace has not been so satisfactory as it has been in other locations, partly due to the furnace itself. When they would reverse the furnace, any obstruction that happened to be on one side that was much greater than on the other side, would immediately shut the steam down on the producer. Now, of course, the proper method of correcting the trouble would have been to go to the furnace and eliminate the obstruction, but that seemed to be too much of a round-about way for the open hearth department who were after tonnage, and they simply figured, let's operate from the steam pressure under the control of the first helper, and that is the way we have been doing it, but I still believe there is a possibility of using automatic regulation.

There is one thing that the automatic regulation will show up quickly. If there is any irregularity in the furnace as far as the obstruction goes, it will show it to you immediately, so that you can get busy and correct it, but in the meantime, to keep the tonnage up, it may be necessary to keep on, hand operation.

A. I. & S. E. Meeting

PITTSBURGH SECTION

WRAY DUDLEY, Chairman **R. J. HARRY, Vice Chairman**

THURSDAY, JANUARY 16, 1930

2 P. M.

BLUE ROOM, WM. PENN HOTEL **PITTSBURGH, PA.**

Topical Discussion:

"ELECTRIC OVERHEAD TRAVELING CRANES"

Paper

"CRANE TRACK WHEELS AND CRANE RUNWAYS"

By R. J. HARRY, Carnegie Steel Co., Munhall, Pa.

Report of the Gas Utilization Committee†

WALTER N. FLANAGAN,* Chairman

Special Items By: J. W. JONES, Steam Engineer, Wheeling Steel Corporation, Portsmouth, Ohio; A. G. WITTING, Asst. Chief Engineer, Illinois Steel Company, Gary, Ind.; J. C. HAYES, Combustion Engineer, Freyn Engineering Company, Chicago, Ill.; W. E. BISLER, Combustion Engineering Corporation, New York, N. Y.

Discussion

Discussed by

T. R. Kathner, Duraloy Company, Pittsburgh, Pa.
H. V. Flagg, Fuel Engineer, American Rolling Mills Company, Middletown, O.
R. C. Vroom, Peabody Engineering Company, New York, N. Y.
F. E. Leahy, Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, O.
H. C. Seibert, Fuel Engineer, Bethlehem Steel Company's Properties, Bethlehem, Pa.

Mr. Kathner: May I supplement some of Mr. Jones' remarks on that, please? I happen to be familiar with what the flaming of fuel will do to the insulated shaft. I happen to know about this because I put in the installation for him, and while his figures are reliable, it should be supplemented by paying that part of the fuel economy was due to the use of an insulated shaft, and the remainder because of the use of insulation on the bottom part of the furnace.

Now in connection with your Theisen gas washers, I had the opportunity of starting one of them in connection with a normalizing furnace at Gueugnon, France, in February, with its performance exceeding all expectations. This washer is being used in Belgium, Germany, France and Italy. They all seem to be very well impressed with the service they get out of it; so I can supplement Mr. Hayes' paper by saying that the steel corporation of Germany is also using the Theisen disintegrator, in conjunction with the Ruhr Gas, which is a combination of pooled gases from the chemical, coal and steel plant industries.

H. V. Flagg: One thing I was interested in is the discussion of the question of luminosity and its influence on heat transfer. The question in my mind is whether it is the luminosity of the flame that has most to do with the heat transfer or the amount of the flame and the area it covers. Thorough mixing of fuel and air shortens up the flame and throws intense heat over a comparatively small area of the bath, but the rest of the bath is freezing up at the same time; so it looks to me if you could get complete combustion with a flame that could be spread over the whole hearth, that you could get the heat transferred from a flame with almost perfect combustion characteristics even though it had low luminosity. Of course, that is a large order, but I am wondering if we can't find some means such as air under pressure, to get complete combustion quickly and still have enough velocity to carry the flame across the bath before the combustion is completed.

R. C. Vroom: In connection with the difference in radiation from luminous and non-luminous flames, you may be interested in some tests that were made at one plant where our burners are installed under boilers.

At times there was burned natural gas with an entirely non-luminous flame, and at other times oil with a highly luminous flame. The furnaces are water-cooled with a refractory face bolted to the tubes. Some tests were made when burning gas and oil respectively at about the same rates of heat liberation in the furnace, and it was found that with a non-luminous gas flame, the heat transmission to the walls was less than 1 per cent below that which was obtained with a highly luminous oil flame.

F. E. Leahy: Some years ago we were concerned mainly with the generation of steam in our regular operations in the steel mills, but today our big problem is metallurgical heating, and the application of fuel to get the most efficient and economical results. Probably the open hearth is one of the most fertile fields of attack right at the present time.

We are interested today in getting out large tonnages, and we can use all we can make. That is everyone's condition at the present time. In the making of steel we are concerned with getting it out at a low cost. In the operation of an open hearth furnace it can be separated into phases. First, is the melt-down period, getting the metal under cover. And then we have the refining period after we have completed the melt-down. The handling of a furnace on the melt-down has, in some cases, been worked out very efficiently. They have gone to what is sometimes called the blow torch furnace, but in order to get speed, in many cases have burnt the furnace down.

In this theory of luminous and non-luminous flame that has been discussed today, the application of that would mean—one phase of it would be that we have a gas fuel at a period with an intimate mix, and high temperature, and melt-down fast, and then we come along with a liquid fuel, and replace the gas fuel with a liquid fuel, or with our gas fuel you change the conditions under which you are burning it so as to get the luminous condition, or a slow burning flame.

We know that we can get a quick melt-down with gas and we also know that we get on an average with liquid fuel much longer furnace life. With the liquid fuels during the time when we are at the refining period, invariably our roof is at a very satisfactory relatively low temperature compared to the flame, that includes producer gas and coke oven gas.

A number of operators have attempted to get a

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†Presented at Annual Convention of A. I. & S. E. E., Pittsburgh, Pa., June, 1929.

decrease in refractory cost, but have been only able to get it by a corresponding increase in fuel cost. Now, both of those conditions of low cost of fuel and low cost of refractories can be obtained providing more flexibility is available in the open hearth furnace than it has at the present time. A few operators have, and the results would indicate that it would let us at the very outset get a very quick melt, and at the refining period we should be able to get a luminosity to a liquid flame.

H. C. Siebert: I don't know that I can add anything to what has already been expressed, and Mr. Leahy has outlined the trend in the open hearth game pretty well, which is the most important factor, I think, in the utilization of by-product gases. Many plants have started out making experiments in open hearth furnaces along that line, and I do not believe that the experiments have progressed sufficiently to warrant setting forth definite conclusions.

As regards the luminosity theory, the paper that was presented by Mr. Witting was very interesting, but I personally have often wondered whether the luminosity theory hasn't been worked overtime. I think there has been a great lack in obtaining engineering information on the fundamentals of open hearth practice. I think if we compare that portion of combustion with combustion as it is developed today in large boiler plants, I think there is a big contrast, and certainly it is in favor of the boiler plants.

I was very much interested in hearing the previous speaker's comparison on the relation of luminosity and non-luminosity as made on the boiler plant at California in furning fuel oil and natural gas. I think it certainly was a very interesting comparison.

I do know that one plant in Europe—I was talking to a gentleman three weeks ago who had paid a visit there last year, and called attention to the fact that he was very highly impressed with the operation of that plant—they use straight coke-oven gas in the open hearth furnaces. These furnaces were very much simpler in design than the standard furnace usually found in the steel plants in this country.

There they work on the idea of maintaining coke-oven gas at a certain velocity at the port. There is really no port. The only port is the water cooler, similar to a tuyere cooler as applied in the standard blast furnace. At the orifice they maintain a certain pressure and get a certain velocity. I think they maintain that pressure at about 10 or 12 inches of water, and the velocity is about 150 feet per second. As long as they hold that condition, they have no difficulty whatsoever in getting good fuel economy in the open hearth furnace on straight coke oven gas. My recollection is that the fuel rate per ton ingots on those furnaces is about 4,500,000 b.t.u., I think, charging about 35 or 40 per cent.

I believe in the past we have theorized quite a lot on luminosity, and on the breaking up of hydrocarbons and have paid very little attention to pressure. This is a field that certainly warrants the serious thought of all engineers. Controls such as we have today under very low pressure are very poor, and bring in all of the evils connected therewith, big gas ports and water cooling devices in order to hold the ports. While the other way, with a little higher pressure, all such complications will disappear.

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*Some Methods of Best Utilizing Electrification in the Steel Industry**

By G. E. STOLTZ†

Discussion

Discussed by

C. S. Proudfoot, General Manager, Vanadium Corporation of America, Niagara Falls, N. Y.

Brent Wiley, Assistant to Industrial Sales Manager, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

C. S. Proudfoot: I was very much interested in hearing Mr. Stoltz's paper, and would like to refer to the question of the long delay in changing the various steam driven blooming mills located in the Pittsburgh district from steam to electric driven, after the motor driven mills had been proven so highly successful and faster and more efficient than the steam driven unit.

I am of the opinion that this delay was partly due to the failure of the Electrical Engineer in the steel mill to put the question of changing before their management with sufficient force and clearness that he would have but one method to pursue,—that is, changing to electric drive. This change naturally meant considerable expense, as it was necessary to install new power house equipment and other auxiliaries in addition to the mill drive. The cost covering this equipment was far greater than the price of a new steam engine, and in a great many cases the first cost ruled and the engine remained in operation.

The question referred to by our Chairman, Mr.

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*Presented at Annual Convention of the A. I. & S. E. E., June, 1929, Pittsburgh, Pa.

Cramer, in regard to the production of Pig Iron by the use of electric power is in its infancy, but not as far off as one would suppose, as the development in the nature of a shaft furnace with electrodes entering the furnace at or near the base. While these furnaces are not of a very large capacity, the development in the course of a year or two will, I think, attract considerable interest to Electrical and Metallurgical Engineers.

Brent Wiley: Progress in the electrification of the steel industry is accomplished by the use of apparatus of improved design and by the further utilization of existing apparatus in new applications.

The steel industry was one of the first to recognize the advantages of the free interchange of ideas between companies. The advantages and practical benefits of improved practice are thus known promptly to those who are interested in investigating the subject. By having the actual facts available, every proposition is fertile ground for still further improvement. Ideas beget ideas and as they pass around a community or district, they naturally build toward perfection. The ultimate, of course, is never reached for conditions and requirements change and there is a continous store of discoveries as made by research departments and design engineers to propagate improvements.

One of the objects of an apparatus exhibition, such as the Iron and Steel Exposition, is to acquaint the public with the status of the art in reference to the various lines of apparatus used in the industry. What is accomplished by the use of improved devices, new applications, etc., largely form the subject matter of papers and discussions, as this phase of development cannot be displayed, as a rule, and it requires field investigation to obtain a full appreciation of the improved quality of product, economy of operation and in fact the general result, which is a most important consideration.

The urge to make improvements is a natural, human characteristic and industrial expositions tend to develop this urge into a real desire, as they present concrete suggestions. The urge to make improvements also comes from other sources such as demands of the trade which might require, in the case of the steel industry, higher grades of finish of metal product, exactness regarding uniformity of quality and extreme limits of variation regarding dimensions; also the urge may come from the desire to operate with greater economy.

The next step is to study the means of making improvements. From an engineering point of view, a great deal is accomplished by having a thorough knowledge of the status of the engineering art as applied to the particular apparatus involved. It has been suggested that by close co-operation of industry and engineering and manufacturing companies, a better understanding could be obtained regarding the vast resources available for accomplishing improvements. We have reference to the question of initiating improvements, the time factor in carrying them out, and the latitude of improvements.

A large manufacturing plant such as the Westinghouse Company has as part of its organization, not only a design engineering department, but also an extensive research bureau which is devoted principally to a thorough analysis of the fundamentals of improved design. The various phases of research work cover a large number of subjects in a very complete manner and these subjects are often matters of interest to a number of other companies, as they are associated with the problems and studies which they are making in reference to improvements in their particular lines of activity. Unquestionably there is a very limited appreciation of this question of overlapping interests, and we wish to present the thought that it will be of mutual advantage to have a closer working arrangement between industrial companies. By a more general interchange of information regarding industry problems of a manufacturing nature, it will develop that the solution of the problems presented can be found in rather unexpected places, and with a better understanding of each others problems, a quicker and more thorough solution can be obtained.

As an illustration of how these things impress a representative of an industrial concern, we recently had the pleasure of having a high official of one of the leading steel companies visit our research laboratory. He was very much pleased with the demonstration as made in the polarized light machine, which illustrated in a very plain and conclusive way, strains in various shapes that were under stress, thus showing in a practical and conclusive way what primarily had been limited to a theoretical calculation. This, the representative stated was of inestimable value and he considered that it had many practical applications which would simplify and improve engineering practice. Undoubtedly there are an unlimited number of cases such as mentioned above, which would have a wide application and careful consideration should be given regarding the development of a co-operative plan of utilizing all the facilities available to better advantage.

There is another phase of development work that can be carried on in a more effective manner. A manufacturing company, such as the Westinghouse Company, develops a great many devices which initially have a rather limited application. Fundamentally, they may be of such a nature that they would have a very wide application if the manufacturing company was sufficiently versed in industry needs and demands to recognize the usefulness of the devices. Here again, close co-operation of the various industries with the manufacturing plant will assist in carrying on improvements by widening the scope of usefulness of devices as they are developed, as the men in the field should by virtue of their contact with the requirements and problems of a particular industry, recognize more readily how the new and improved devices can best serve their needs.

*Selecting Electrical Equipment**

By L. A. UMANSKY

Discussion

Discussed by

J. C. Reed, Electrical Engineer, Bethlehem Steel Company, Steelton, Pa.

A. F. Kenyon, General Engineering Dept., Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

R. M. Hussey, Elec. Supt., Jones & Laughlin Steel Corp., Aliquippa, Pa.

F. O. Schnure, Elec. Supt., Bethlehem Steel Company, Sparrows Point, Md.

H. S. Page, General Electric Company, Schenectady, N. Y.

J. C. Reed: To ask me to discuss any paper which Mr. Umansky writes, puts me in the position similar to a man who was asked if he had ever met or heard of a perfect man. He said, "Yes, I have heard of such a man." Upon being asked who the man was, he said it was his wife's first husband.

Now I don't mean to infer by that that Mr. Umansky is a perfect man, but his paper has come so near to being perfect and thorough in all the details that it would seem foolish for me to take a position in opposition to anything which Mr. Umansky might have said, and to agree with him, of course, would be entirely superfluous. So I don't know that what I will say will be of any benefit to those who are listening.

There are a few points, however, in the matter of selecting electrical equipment which might be worthy of consideration. Take, for instance, the application of a motor to a fan of a waste heat boiler used in connection with an Open Hearth Furnace, where you expect the motor to run continuously throughout the year, excepting during such periods as the furnace might be relining; it pays to look very carefully into the matter of efficiency.

Twenty-five years ago when I first started to apply motors in the Steel Industry, efficiency was the main talking point of the motor salesman, and he would show you how much money you would save purchasing a highly efficient motor, and we would be so blinded by this line of argument that frequently we would forget to look into the more important construction features.

To show that no matter how much experience you may have had in selecting motors for various steel mill applications you are always liable to make mistakes, I wish to refer to another application, that of applying a synchronous motor to a pump. Following a rather expensive interruption due to failure of power and a loss of water supply, we thought it would be desirable to have one of our main supply pumps arranged so it would operate from an outside source of power supply. So I selected a self starting synchronous motor, one which could be thrown across the line, thus eliminating as much controller equipment as possible.

I had two propositions to choose from; one which would pull in to synchronism with full load torque, the other with about 50% full load torque. The latter motor was considerably cheaper and also gave us higher operating efficiency which was a consideration, since we were going to purchase this power. To start the latter motor, however, required that the main valve be closed and a small by-pass valve opened, at the time of starting, then after the motor had pulled in to synchronism, the main valve had to be opened.

After consulting the Chief Engineer, it was decided that the pump tender was not so busy but that he could easily operate the valves. Now this arrangement would have been O.K. if we were going to let this pump run as a continuous operation since then it would have been only necessary to do this once in a while, but if the pump was to stand idle and be ready in a moment's notice to get it on the system, the time required to manipulate the valves was entirely too long so that it became necessary to make a considerable expenditure to fix things so that the valves could be changed more readily. It was a clear case of not being sufficiently posted on the hydraulic end of the job. The saving in the original purchase of the motor was more than wiped out in making the valve changes.

In the purchase of most of our motors we pay very little attention to efficiency. What we want is a motor which will stand up at all times and be reliable and cause as little expense in repairs as possible. For continuous operating equipment we look into the efficiency. In the purchase of conversion equipment such as motor generator sets or rotary converters we have under consideration the problem of power factor correction as well as efficiency.

The location of such a machine determines largely what you should purchase, so each individual application has to be given careful consideration, and I am sure Mr. Umansky's paper will prove to be a very valuable contribution to the industry and one to which we will all frequently refer and from which we will receive aid in solving the many problems which will confront us from time to time. I wish to take this opportunity to congratulate him upon not only the valuable information which he has given us but also upon the very able and interesting manner in which he has presented it to us this morning.

R. M. Hussey: Mr. Umansky's paper was very interesting, and it is just the kind of paper we would expect to come from Mr. Umansky. It is very easy for me to get up here and agree with everything there is in it, but I don't know. Somebody told me not to agree with everything there was in it.

In all sincerity, however, Mr. Umansky disposed

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*Presented at Annual Convention of A. I. & S. E. E., June, 1929, Pittsburgh, Pa.

of his switching equipment soon after he got his propositions in a rather easy way, and it can be disposed of in short order, providing some investigations have been made as to rupture capacity and thermal capacity. But supposing you were putting in additional generator equipment or changing lines, or in any way doing anything that might require switches of different rupturing capacity or thermal capacity than those used previously. Then maybe you could not dispose of that part of your proposition quite as easily.

It may develop that you would have to make further investigations as to what size switches you were going to need or to check the size switches for thermal capacity and rupturing capacity that were proposed.

It has been the experience of some of us, that checking or making investigations and studies, to arrive at the proper size of switches for rupturing and thermal capacity cannot be done in a short time but will require some more time than to get your proposition for this new blooming mill and arrive at the kind of equipment you want.

A. F. Kenyon: Mr. Umansky has presented a very interesting and complete paper on the Selection of Electrical Equipment. In only a few cases can I disagree with him, and there is not a great deal to add to his remarks.

He has mentioned synchronous motors, particularly to drive motor generator sets, and I take it that his remarks would also apply to synchronous motors which are applied to driving a rolling mill directly.

He has stated that unity power factor motors are more efficient and therefore have lower losses than an 80% power factor machine. In this connection, it should be kept in mind that most mills require motors having pullout torques of at least 200% and in many cases the pullout torque is specified as 250% and occasionally as high as 350%. Such machines can be designed for unity power factor operation, but can be more easily designed, and follow more nearly standard practice, if they are designed to operate at leading power factor of 90 or 85 or 80 per cent. Also it should be noted that a machine designed to operate at a leading power factor at full load will operate at a higher leading power factor at some increased load, or at unity power factor at some still higher load. Similarly a motor designed to operate at unity power factor at full load will operate at lagging power factor at any overload, unless the control is arranged to increase the excitation as the load comes on.

Mr. Umansky has mentioned the recent improvements which have been made in bearing designs, resulting in considerable reduction in weight, but of equal or greater strength due to the better disposition of material. Improvements have also been made in the lubrication and cooling of large motor bearings. It was usual a few years ago, especially on large reversing motors and flywheel motor generator sets where the bearings were heavily loaded, to specify water cooling, and a good many such water cooled bearings have been applied.

It is difficult to manufacture a bearing, and get a good job of babbitting around a water cooling coil in the bearing shell. There are also the operating difficulties due to leaks in water pipes, and freezing in cold weather. For these reasons, heavily loaded bearings are now being operated with flood lubrication, circulating about the same volume of oil over the journal as the water previously circulated through the cooling coils. Cooling and lubrication are thereby secured with the same oil medium.

F. O. Schnure: It goes without saying that in the United States the manufacturers of steel mill electrical equipment are reliable manufacturers, and we, therefore, don't need to go into the integrity of these companies and their ability to stand by the performance of their equipment in future years. We know also that their engineers are just as much interested in the performance of that equipment as we are who buy and operate it. That is one point to which we need not pay much attention.

Mr. Umansky finally agreed with himself that he would buy the motors, or the electrical equipment, on performance. Performance of electrical equipment particularly reversing motors, is measured over a good many years, and during those years a reversing motor is going to reverse a good many million times. It is going to break a good many lead spindles. There are going to be a good many slips in the setting of the screw-down, it will take four and six inch drafts instead of two. There will be a good many plates doubled up, and those motors will have to go through a good bit of grief. One don't want to come out when the lead spindles break or any of those things happen and find you have a broken shaft or a broken bearing pedestal, or something else that is just as bad, because as time goes on the circuit breaker setting naturally goes up.

Our steel mill engineers or our steel mill operators haven't yet found the secret of rolling steel. One day they will roll it hot and the next day they will roll it cold; all, of course, in the quest for a better product. I would, therefore, say that in selecting equipment it ought to be bought plenty large enough.

If a motor frame can be built of rolled shapes that are as serviceable as the cast shapes, then we as steel producers should use rolled shapes.

Another point in the selection of equipment is the duplication of equipment that you have in your plant. It is a very good point to buy equipment so that a rotor or an armature can be carried that will act as a spare in several mills. It is also very convenient to be able to hold down your spare armatures, field coils and bearings, to the minimum.

I would say then, in conclusion, that the equipment should be plenty large enough and should be duplicated as much as possible.

H. S. Page: I am not surprised that your chairman has appealed to all engineers to make every effort to bring about more stable conditions in regard to the question of rating. Recognized standards that I recall are the Continuous Rating, Short Time Rating, Nominal Rating and Intermittent Rating. Multiply these by the number of temperature rises generally accepted, i.e., 40°, 50° and 75° and we have a condition that is confusing to say the least. It would simplify the work of the engineers if we could have a single measuring stick to apply on all ratings. I have obtained the impression that Sales Agents and Purchasing Agents enjoy talking in big figures and to them the rating giving the highest horse-power is the most attractive. This tends to

lead the designer to offer larger and more expensive apparatus than is actually required, but fortunately most of the confusion is avoided by close co-operation between the operating and application engineers.

L. A. Umansky: I feel myself second to none in thinking very highly of the efforts of the pioneers in the electrical industry who built some good motors in the old days. We all know that some of these machines are still going strong but we are apt to forget and lose sight of a number of their contemporaries which are here no longer and which have been sent to the graveyard a long time ago. I say that we forget this fact and just because we have a few old motors still running, we think that nowadays the machines are not built as good or as conservative as they were before. This is, of course, not true. The engineers knew much less about the machine design fifteen or twenty years ago than they do now. Very often they had to guess. If they guessed on the right side, then they produced a good and strong machine. We all know that a number of such guesses were on the wrong side and the products of such cases have long been discarded.

Nor will I disagree with anyone calling for a comfortable margin in selecting the capacity of an electric drive. In this connection I wish to emphasize one point which I have mentioned more than once before this Association. Let us, after all, arrive at one uniform method of rating our machines. Take, for instance, the situation as it exists today. Some of the machines are still rated on a 35 degrees C. basis, some on 40° and some on 50°. In the list of installations published every year in the "Iron and Steel Engineer," the horsepower of each drive is given, but the temperature rise is omitted. This destroys to a great extent the usefulness of this otherwise very valuable information. Some may look at this list and say "Here is a certain plate mill with a 4,000 h.p. motor and here is another similar mill on which it has been decided to use a larger motor rated 5000 h.p." For all we know, these two motors may be exactly the same, only one is rated on a 35° basis and the other on a 50° basis. Just by calling Bill by the name of William does not make him any bigger.

I agree with Mr. Hussey that oftentimes the selection of the proper oil circuit breaker equipment is not an easy task. If this is the impression which may be derived from my paper, then I did not express myself in a sufficiently clear manner. The point which I was driving at was this: the selection of switching and control apparatus does not involve any "mystery" design. The cards are laid on the table and the necessary calculations may be readily followed by or made independently by the purchaser's engineers. There are no manufacturing problems involved. On the other hand, a motor or a generator is a self-contained device whose design and therefore value may not be analyzed except by an expert in the designing line.

I agree with Mr. Kenyon that it is far easier to build a leading power factor synchronous motor with a high pull-out torque than it is to design a unity power factor machine with the same value of torque. However, just because the former design is easier, it does not follow that we should apply leading power factor machines without discrimination because a high value of pull-out torque is needed.

It always seemed to me to be a crime against sound engineering to apply a synchronous motor which would be running for 24 hours a day, 365 days a year, with a leading power factor (in excess of any power factor correction requirements) just because we may need in a few instances in the year a high pull-out torque. In cases of that nature it certainly is better to provide control devices which will automatically strengthen the motor field during these few seconds a year than to install a motor much bigger than necessary and which will operate for 99.99% of the time with poor efficiency and high running light losses.

I wish to thank the Association for the interest shown in the present discussion. I hope someone will come across and present before long a far better paper than was presented today, commenting on the points which we have discussed, or analyzing the matter from a more interesting angle.

A. I. & S. E. E. JUNIOR DIVISION

(Devoted to practical problems of electrical department employees in the Iron and Steel Industry)

Regulation of Alternating Current Generators

In presenting this information taken from Westinghouse Electric & Mfg. Company's testing manual, the Association of Iron and Steel Electrical Engineers feel that the man in the field may find many valuable suggestions that will aid him in his future problems in maintenance.

It is recommended that the Junior Member study this article carefully with the view of increasing his knowledge and effiency in handling, operating and maintaining Alternating Current Generators.

Articles of this character and description will appear regularly in the columns of the Junior Membership Section of the Iron and Steel Engineer. *Editor.*

The regulation of an alternating-current generator is seldom determined by actual test due partly to the difficulty in most cases of obtaining the proper load conditions but mainly because of the regulation as computed from the no-load, zero power factor and short circuit saturation curves, is more accurate and dependable than can be obtained by ordinary methods of testing.

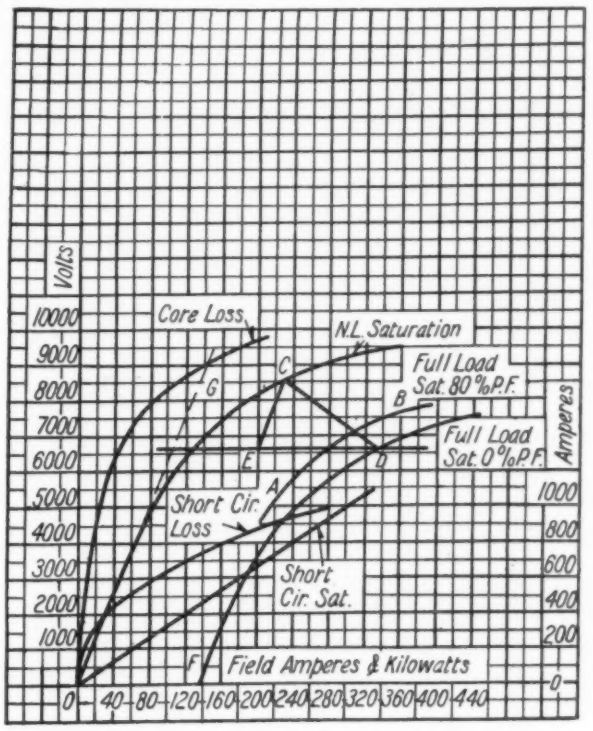


FIG. 1.

The method of computing regulation at any given power factor, as for example 80 per cent is, as follows:

From the saturation curves, Figure 1, assume values of field current such as will cause the desired curve AB to pass through the normal voltage line, as follows:

Field amperes (Assumed)	240	280	320
Terminal volts, no-load (from curve)	8700 (cf)	9050 (bc)	9350 (ad)
Terminal volts, full load at zero power factor (from curve)	4900	5700	6400
Volts total drop	3800 (oc)	3350 (ob)	2950 (oa)

On rectangular co-ordinate sheet (Fig. 2) take a base line OB, with O as center, draw a quadrant of a circle CDB with a radius of 100 parts, the base line OB being a measure of the power factor.

On this circle CDB lay off the desired power factor 80 per cent at D and draw a line connecting O and D.

Divide the line OA into any convenient scale of volts, from O lay off on OA the values of total volts drop Oc, Ob and Oa.

From the paint a, draw a line equal to the terminal volts at no load ad, intersecting the line OD at d; the value of volts (7220) as measured from d to O, using the same voltage scale as was laid off on OA, will be the terminal volts obtained with full load current in the armature at 80 per cent power factor and a field excitation of 320 amperes. Proceed in the same manner with the points b and c measuring the resultant voltage on the line OD.

Then for a field excitation of 240, 280 and 320 amperes with full load current at 80 per cent power factor, the respective voltages will be:—

Field amperes	240	280	320
Terminal volts	5750 (Of)	6650 (Oe)	7220 (Od)

Plot as shown in Figure 1, obtaining the load saturation curve AB and from this curve the required field current (276 amperes) is obtained to maintain normal voltage (6600) with full load current at 80 per cent power factor, with 276 field amperes and no load voltage is 9030. The per cent regulation at the above load, therefore,

$$\text{is } \frac{9030 - 6600}{6600} \times 100 = 36.8\%$$

The construction as used above is approximately correct for all values of power factor below 90 per cent but for any power factor above 90 per cent, it is necessary to take the ohmic drop into consideration. This will modify the diagram shown in Figure 2 to that shown in Figure 3. From the point O lay off to the right the value of ohmic drop Og. Then from the point g, erect a perpendicular gA. Then draw lines Oc, Ob and Oa, equal to the total drops, intersecting gA at c, b and a. From these points draw lines with values equal to the terminal volts at no load intersecting line Od at d, e and f. The value of volts measured from O to d, e and f will be the respective terminal volts. This additional correction can be neglected at power factors below 90 per cent, as it has very little influence on the regulation, except in very low speed machines, when the stator resistance is relatively high, or in cases where regulation at high power factors is required.

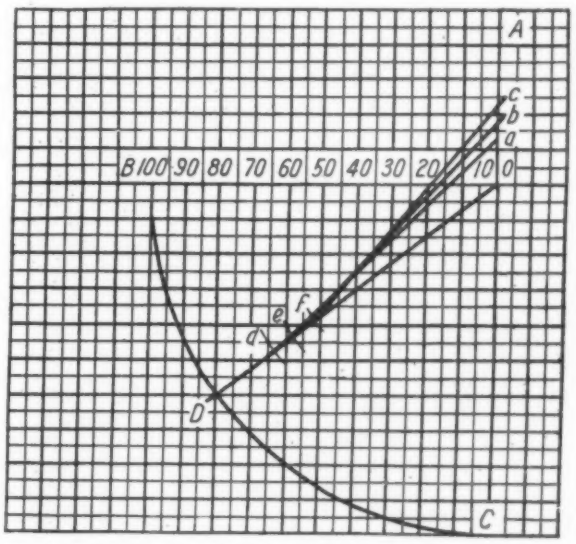


FIG. 2—Diagram Showing Method of Obtaining Saturation Curve at Any Power Factor.

If the regulation is desired at any other load than that at which the load saturation curve is taken, it is necessary to calculate another load saturation curve at the desired load. The distance between the curves on line CD, Figure 1, or on any line parallel to CD is proportional to the load. The line CD is determined as follows:

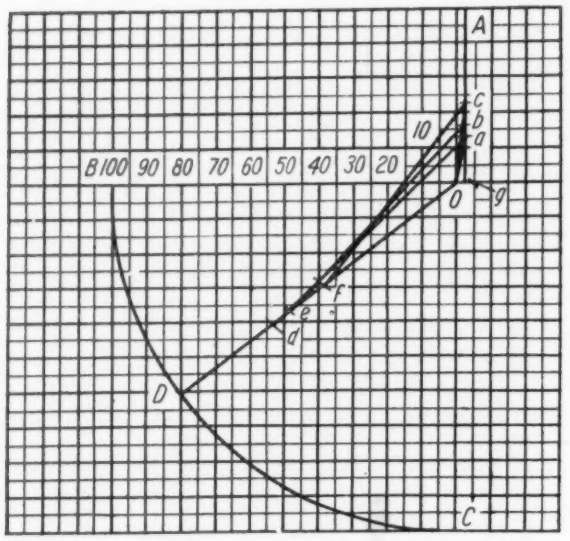


FIG. 3—Diagram Showing Method of Obtaining Saturation Curve at High Power Factor.

On the normal voltage line from the point D on the load saturation curve lay off a distance DE equal to the short circuit field amperes OF at the base of the curves; from the point E draw a line parallel to the air gap line, OG, intersecting the no-load saturation curve at C; connect points C and D.

Points on the zero power factor load saturation curve at any other load that may be desired can be obtained by laying off on the line CD and lines parallel to CD, from the no load saturation curve, the length CD being 100 per cent, the values corresponding to the desired load. Then draw a curve through these points. If then it is desired to obtain the current for this load at normal voltage and any desired power factor, it is necessary to proceed, as outlined for the full load saturation.

EFFICIENCY BY LOSSES

The efficiency can be obtained from the resistance, iron loss, short circuit loss and calculated field amperes.

The losses should be calculated at each quarter load up to 25 per cent overload.

Let E=Normal terminal volts.
I=Amperes per phase.
I_1=Equiv. single-phase amperes.
i=Field amperes at load I.
R=Resistance between terminals at 75°C.
r=Field resistance at 75°C.

Then 1=Ohmic drop per phase in stator winding =e (see table below).
2=Total induced volts E + e for generators. E — e for motors.
3=Iron loss at induced voltage (2) obtained from iron loss curve.
4=Field copper loss i^2r.
5=Stator winding copper loss (see table below).
6=Load loss=S. C. loss — (5).
7=Friction and windage (if to be included).
Total losses=3+4+5+6+7.

Output=E × I_1 × power factor.
Input=Output + total losses.

$$\text{Efficiency} = 100 - \left(\frac{\text{Losses}}{\text{Output} + \text{Losses}} \times 100 \right)$$

Table for calculating ohmic drop, stator winding copper loss and equivalent single-phase current of different windings.

	Ohmic Drop	Stator Copper Loss	Equiv. Single-Ph. Amps.
Single-Phase	IR	I^2R	I
Two-phase	IR	2.0 I^2R	2.000 I
Three-phase star or delta	0.866 IR	1.5 I^2R	1.730 I
Six-phase closed Diametrical connection	1.333 IR	4.0 I^2R	3.000 I
Six-phase open Diametrical connection	IR	3.0 I^2R	3.000 I
Six-phase closed Double delta connection	1.300 IR	4.5 I^2R	3.465 I
Six-phase open Double delta connection	0.866 IR	3.0 I^2R	3.465 I

On two and three-phase machines, the ohmic drop (e) and the stator copper loss can also be computed by using the equivalent single phase amperes and multiplying by one half the resistance between terminals.

$$\text{as } \frac{IR}{2} \text{ and } \frac{I^2R}{2} \text{ respectively.}$$

Calculation of Efficiency by Losses at 80 Percent Power Factor

Stator resistance per phase at 75°C.				0.1107
Field resistance at 75°C.				0.3112
Load		½	¾	F.L.
Line amperes per terminal	I	228.50	342.75	457.60
Field amperes	i	200.00	237.00	276.00
Terminal volts	E	6600.00	6600.00	6600.00
Stator winding copper drop	e	21.90	32.85	43.76
Total induced volts	2	6621.90	6632.85	6643.76
Iron loss	3	43.80	44.10	44.50
Field copper loss	4	12.44	17.48	23.70
Stator copper loss	5	8.68	19.50	34.77
Load loss	6	1.32	5.50	12.23

Factory Testing of Electric Apparatus

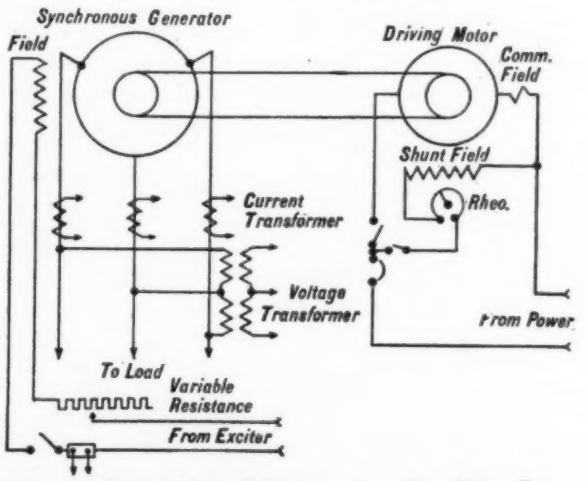


FIG. 4—Connection Diagram for Loading Synchronous Generator, Reverse Conditions for Loading Synchronous Motors.

Friction and windage	24.30	24.30	24.30
Total losses	83.54	110.88	139.50
Kv-a output	2608.90	3913.50	5224.90
Real kw. output	2087.12	3130.80	4179.92
Real kw. input	2170.66	3241.68	4319.42
Efficiency	96.15	96.57	96.77

On Synchronous Motors, the efficiency is computed exactly as above, except that the stator copper drop is subtracted from the terminal volts to obtain the total induced volts and the denominator of the efficiency equation, paragraph 48, becomes the "input minus the losses" instead of "output plus the losses."

METHODS OF LOADING SYNCHRONOUS MACHINES

The methods used for obtaining the load for this type of machine are divided into two classes.

1—With the machine running under actual load of the desired characteristics.

2—With the machine running under a compromise load which approximates the actual load condition.

1—Actual Load Tests

Actual operating conditions on a generator are obtained in two ways:—

A—By loading on resistance.

B—By loading back on the line.

For these tests, the machine is belted or coupled to a direct-current motor capable of carrying at least 25 per cent overload on the machine under test. Connections should be made as shown in Figure 4.

Conduct of test—After the necessary meters are selected and connected in their proper places and the wiring checked, start the machine from the direct-current driving motor and bring up to normal speed. The driving motor should never be run at more than 15 per cent above rated speed.

When loading on resistance.—Close the field circuit of the generator and increase the field current gradually until normal voltage is obtained. This is to check the connections only. Open the field circuit, close the line switches and set the resistance to give a small load on each phase; then close the field circuit again and increase the voltage to normal, adjusting the load on each phase until the desired load is obtained and the current in each phase is within one per cent of the average. Loading direct on the resistance gives a power factor very close to 100 per cent. This method is seldom used as other methods give practically the same data at a considerable saving in power expended.

When loading back on the line.—After the machine is brought up to normal speed, excite the field to give a voltage corresponding to the line voltage, which should be set as near as possible to the rated voltage of the machine on test. Before paralleling an alternating-current machine with the line, it must be phased out and synchronized before closing the switches. After the machine is on the line, set the field current of the generator to an estimated value to give the power factor required and decrease the field of the driving motor slowly until the rated stator winding amperes are obtained; then take wattmeter readings, holding the stator winding amperes constant. If the power factor is not correct, make the final adjustment of the generator field gradually to avoid any tendency to surge.

In loading a Synchronous Motor, proceed in the same manner as a generator, but the field of the direct-current machine is to be increased to obtain the specified load.

When the alternating-current unit is part of a motor generator set, the load on the direct-current end of the set should be held to its correct value.

2—Compromise Load Tests

Compromise load tests are those which are made on the various parts of a machine to approximate the required load conditions. The chief methods used are as follows:—

a—Specified load at approximately zero per cent power factor with normal voltage.

b—Specified load at approximately zero per cent power factor at field amperes to give 100 per cent power factor at full load.

(a) Specified load at approximately zero per cent power factor with normal voltage is the standard for determining the temperatures on all synchronous machines with fields designed to operate over

Factory Testing of Electric Apparatus

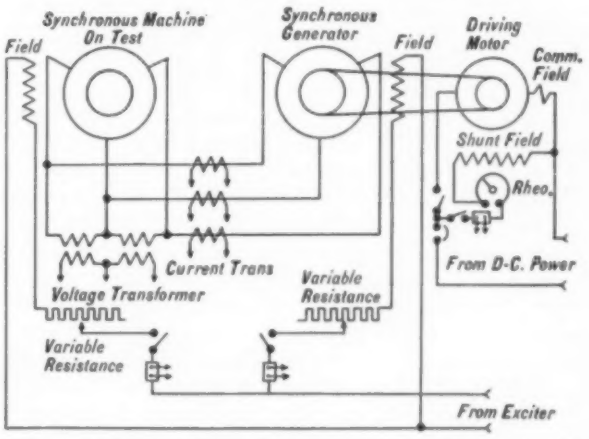


FIG. 5—Connection Diagram for Full Load 0% Power Factor Saturation.

excited, and is made at normal armature current and normal voltage unless otherwise specified on the test data sheet.

The machine under test is run as a synchronous motor in parallel with a power supply circuit of similar characteristics and with its field over excited sufficiently to cause the desired load amperes to flow in the stator winding. When two similar machines are available, it is very often desirable to run one of the machines as a generator with under excited field and the other as a synchronous motor with over excited field.

Connect the machine, as shown in Figure 5. Use suitable current transformers for measuring the current in the stator winding.

The readings required on this test are speed, field volts and amperes, stator volts and amperes on each phase.

Conduct of Test.—After the wiring has been checked and all meters properly connected, start the machine by the most convenient method, synchronizing when necessary.

Increase the field current on the machine under test and decrease that of the corresponding unit, holding the voltage constant, until the desired stator

current is flowing. Take a complete set of readings. The power factor of this test will usually vary on the different machines between 7 per cent and 12 per cent, depending on the total losses, but should never exceed 20 per cent.

(b)—Specified load at approximately zero per cent power factor at field amperes to give 100 per cent power factor at full load. This test is chiefly used in connection with synchronous motors as they are usually designed to operate at 100 per cent power factor. This test gives reliable temperatures of field copper, field iron and stator copper. Record readings of speed, field volts and amperes; also stator volts and amperes on each phase.

Conduct of Test.—Connect the machines as in (a) After the wiring has been checked and all meters properly connected start the machines by the most convenient method, synchronizing when necessary.

Adjust the field current of the machine under test to that required to give 100 per cent power factor at full load as determined from the no-load and full-load saturation curves. Decrease the voltage by regulating the field of the corresponding unit until the specified stator current is obtained. Take complete sets of readings every hour until all parts of the machine reach a constant temperature.

TEMPERATURE TESTS

The temperature test to demonstrate the continuous rating must be continued until all parts have reached a constant temperature. To insure this the run should be continued for at least one hour after the temperature shown by thermometers, placed as previously explained in the general testing instructions, and the field voltage have become constant. The time required for the total run will vary from six to ten hours according to the type of machine.

Take readings of terminal volts, amperes and watts, field volts and amperes, speed and temperature. The field volts must be read both on the brushes and on the rings of revolving field types, the latter being used to determine the hot resistance of the field winding.

Select the most convenient method of obtaining the load. Connect the machines as indicated in the diagram for that method. For methods of loading see above paragraphs.

Conduct of Test.—After the wiring has been checked, all meters properly connected and thermometers placed, start the machines by the most convenient method and bring the load to the required value.

Take a complete set of readings every hour during continuous temperature tests and every half hour on tests of short duration. A check reading must be taken with another set of meters at the early part of the test.

The field meters should be carefully checked to make sure that the hot resistance is correct.

The load and voltage must be held at the required values during the entire temperature test. After the machine has been running the required length of time, the power supply circuit should be opened and the field excitation of the machines under test reduced to one-half of the test value. The field circuit must be opened as soon as the machine comes to rest. High speed machines with heavy revolving parts must be stopped as quickly as possible. When a separate driving motor is used, separately exciting its field and loading the armature on resistance racks will assist materially in bringing the unit to a standstill.

When the machine has come to rest, additional thermometers must be placed on the various parts and packed with waste so as to determine the highest temperatures on the following:—

Stator Iron	Collector Rings
Stator winding	Pole Tips
Field winding	Dampers

Bearings (if part of machine)

If the hot resistance of the field winding is desired it may be obtained from the last reading of field amperes and volts taken during the temperature test.

CURRENT ON BEARINGS

All Alternating-Current Generators and Synchronous Motors should be tested to determine whether a current, due to stray magnetic fields, will flow when the circuit between the pillar block and shaft is completed. This is done by completing the circuit through a heavy cable and observing if a spark is obtained when the circuit is broken. If a spark is obtained, the drop between the shaft and the bearing should be measured with a d-c Milli-Voltmeter or an a-c ammeter.

When any current is obtained, the Engineering Department should be notified and they will specify the insulation for the bearing or pillar block.

INSULATION TEST

After all other tests have been completed, the insulation or ground test is made.

The insulation test on the stator winding is twice the rated voltage plus 1000 volts and on the field 2500 volts for one minute. Special cases where other voltages should be used are specified by the Engineering Department.

A. I. & S. E. E. Meeting

CLEVELAND SECTION

A. L. RIECHERT, Chairman — **J. E. WOOD, Secretary**

FRIDAY, JANUARY 24, 1930

ENGINEERS' CLUB — **CLEVELAND, O.**

Topical Discussion:
"ELECTRIC OVERHEAD TRAVELING CRANES"

FRIDAY, FEBRUARY 28, 1930
"THE USE OF VACUUM TUBES IN INDUSTRY"

An Open Letter

FROM GORDON FOX*

Leningrad, U. S. S. R. October 10, 1929.
Mr. John F. Kelly, Managing Director
Association of Iron and Steel Electrical Engineers,
1010 Empire Bldg., Pittsburgh, Pa.

Dear John:

In accord with your request I am sending you a few lines concerning our activities and our experiences here. It would require a volume to relate all but I'll try to cover a few highlights. I am enclosing a few pictures which will convey more than I can describe.

We have really had a fine summer. Letters from America have told of unusually severe heat. We had only a few hot days in July while we were in the South. Just now we are enjoying "Indian Summer" although it does not go by that name here.

We arrived here just prior to May 1 and had the opportunity to see the celebration of that holiday, surely, a most unusual and interesting sight. We took some movies of the event which you may see in due course.

Early in June we migrated south to the Ukraine, where we spent about a month studying a number of steel plants and gathering data. This is the principal steel producing district in the U. S. S. R. During the last fiscal year the group of principal plants in this district, controlled by Ugostal, produced about 2,600,000 tons of pig iron. This is about two-thirds of the total tonnage of the nation.

The steel plants in the Ukraine represent European practice of twenty or twenty-five years ago. The individual plants differ somewhat, depending upon whether German, French, Belgian or English interests prevailed at that particular plant. In nearly every case the layouts are bad, from the viewpoint of modern practice. One can see a number of practices in vogue which only the old timers in America will recall. Not claiming that distinction myself, they have been something of a revelation.

Some fine new coke oven plants are now under construction and a few are already in operation. At the older plants the coke is simply pushed out onto a horizontal or inclined platform in front of the ovens, which serves as a wharf. Here the coke is "quenched" by sprinkling with a number of hoses usually manipulated by women. Coke "crushing" is accomplished, to a very limited degree, by women who crawl amongst the coke on the wharf and tap the large pieces with a hammer. It is then forked into barrows and trundled, perhaps 500 feet to the skip hoist or elevator. Similarly limestone is "sized" by a few stout laborers plying sledges here and there. And so it goes.

At the open hearth, most of the ingots are of small size, one ton or less. These are bottom poured in pits. There are few blooming mills. The small ingots are rolled directly into finished product in mills of the Garret type. For rails and structurals larger ingots are cast. These pass through a reversing blooming mill followed by a reversing finishing mill having two or more stands in train. All reversing drives are steam. Some of the roll train drives in the merchant mills are steam, some are gas engines and some are constant speed induction motors.

There will be many changes in the near future if plans carry through. Much of the old equipment, many of the obsolete complete units are to be scrapped, removed and replaced by modern plant.

*Freyn Engineering Company, Chicago, Ill.

Typical picture of a peasant and his daughters with their offering of berries at the railroad station. One dines "a al carte."

One of the many towers of the Chinese wall at Moscow.

In several instances radical rearrangement of works layout is contemplated. Where warranted, the old equipment will be conditioned and supplemented, with a new furnace here, a new hot bed there, or perhaps a motor drive will replace an engine.

Our study of the Ukraine district has involved seventeen plants. While some improvements are to be made at nearly every plant, it is obviously impossible to remodel them all at once. One of the principal aims of the analysis, in which we have participated, has been the determination of the plants upon which initial efforts shall be concentrated. With this, is involved the allocation of miscellaneous tonnage demands which are expected to grow rapidly from year to year. Mix in a number of economic questions such as freight rates, equalization of ore and coal hauls, housing conditions, market positions, site limitations, water supply, relation to coal and power values and hydro-electric systems, and what not, and you have some idea of the picture.

It now appears probable that the principal new construction in this district during the first five years will be more or less concentrated at four plants. Two of these are now sizable plants. Two of them are relatively small plants which will be enlarged. The total program projected for the district, for the first five years, involves the construction of some fifteen large blast furnaces, several new open hearth plants, one new bessemer plant, six or seven blooming mills and a considerable number of finishing mills of varied types. You will agree that, if this program is carried through, it represents a life sized undertaking.

Three of our American engineers recently accompanied a party of Russian engineers and economists on a tour of inspection to thirteen plants in the Ural mountains. This district is characterized by a preponderance of charcoal iron, due to the immense timber resources and limited coal resources in the region. There are scattered ore deposits, some of which are very low in phosphorus and sulphur. Although these materials are adapted to the production of high grade iron and steel, at present much of the output is used for ordinary heavy products.

In this district there are a considerable number of small plants, most of them rather old and primitive. The use of high grade raw materials enables these plants to produce satisfactory products with a character of operation which otherwise would be prohibitive.

The U. S. S. R. faces a great opportunity. It has extensive resources in ore and in coal, although these are none too favorably situated nor too readily exploited. One of the greatest advantages which the U. S. S. R. enjoys is its potential home market, tremendous in area and great in population. Other European nations are handicapped by boundaries which restrict the disposition of tonnage. Their mills are consequently particularly suited to produce variety at the lowest consistent cost. High-tonnage, restricted-purpose mills, such as we have in America, are not feasible because of the lack of suitable orders. The benefits of the low production costs accruing to such mills, cannot be realized.

The U. S. S. R. has a potential market which will likely be greatly expanded in the next few years. While, in all probability, it will not equal, or even approach the American market in the near future, still it will be great enough to warrant quantity production in specialty mills of American type. This possibility is enhanced by the system of state-ownership which permits concentration of similar orders and avoids the necessity of competing mills each producing a "complete line." Thus, even with smaller tonnages than we have in America, the U. S. S. R. can enjoy a distinct advantage over its European neighbors in the use of American type mills and American rolling methods.

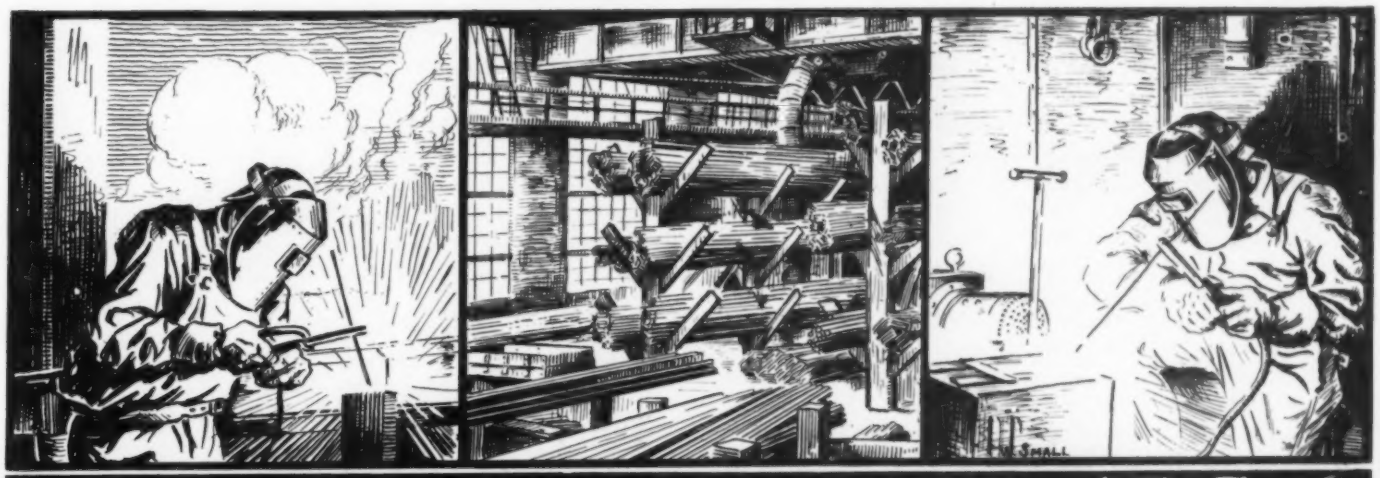
As you may surmise, the work and the life here are both interesting, so time does not at all hang heavy on our hands, at least it has not as yet. If and when the construction program becomes a more definite entity, indications are that we will become ever busier.

I am expecting to remain over here through the winter. I plan to return to the States in the spring, perhaps about the time the golf season gets well under way. I am hoping to be able to attend the next convention.

Please give my regards to our mutual friends.

Yours cordially,
Gordon Fox.

The sky line of the U. S. S. R. This recently completed Gospromishlenost group, located at Kharkov, comprises the tallest buildings in the country. These buildings, of reinforced concrete construction, contain 9,000,000 cu. feet and cost $7,200,000. The offices of Donugol, the Coal Trust, and Iugostal, the Steel Trust, are located here. Last year the writer observed camels in service in the excavation work for part of this group.



FLASHES FROM THE ARC

As a matter of news, practically every pipe manufacturer is either producing pipe today for the trade using some method of electric welding or they are feverishly experimenting with one process or another, to produce Electric Welded pipe for the market. What a change in the last few years; however let us hope that the manufacturers of Steel Products look deep into the future and use this tool, electricity, more effectively in the future than they have in the past.

"Electric Welding of Pipe and Tubing for Boilers, Heating, Refrigeration and Other Uses," by H. A. Woofter, Chief Engineer, Swift Electric Welder Company, 15 illustrations. An article covering the Resistance Welding of Pipe. Claims flash welding 110 per cent or more as strong as the parent metal itself, in pipe welding. With two men and a modern resistance welder, 120, two-inch flues per hour. No claims made for this type of welding in connection with pipe line work. Will always be done by Arc or Gas Welding. "Journal of the American Welding Society," October, 1929.

"Some Recent Developments In Arc Welding," by K. L. Hansen, Northwestern Mfg. Company, Milwaukee, Wis. A paper delivered before the Association of Iron and Steel Electrical Engineers at their Electric Welding and Heating Conference. Very good paper. Will appear in the February issue of the "Iron and Steel Engineer." Paper discussed by Harold Trent, J. C. Cumberland, Charles H. Kenny, A. R. Welch, W. W. Barefoot, A. M. Candy.

"The Application of Arc Welding to Repairs and Manufacturing," by J. F. Lincoln, Lincoln Electric Company, Cleveland, Ohio. Presented at Welding Conference November 13, Pittsburgh, Pa., auspices Association of Iron and Steel Electrical Engineers. Paper will appear February, 1930, issue of the "Iron and Steel Engineer." Claims riveting construction will be replaced by welding particularly large buildings. Mr. Lincoln's paper analyzes the possibility of replacing 7,000,000 tons of castings made each year, with arc welded steel which would provide an additional market for steel of approximately 3,000,000 tons.

"Electric Welding of Field Joints of Oil and Gas Pipe Lines," by Harold C. Price, General Manager, Welding Engineering Company. Two thousand five hundred miles of electric welded lines have been completed. Lines vary in size from 6" to 20" in diameter. All of the pipe welded was equipped with bell and spigot joint. Generators used 200 and 300 amperes. Welding wire used, mild steel, loosely coated. "One of the best contributions to date, of practical arc welding in the field of operation," appears in the October number "Journal of the American Welding Society."

"Using the Electric Arc Process to Weld Cast Iron," by A. R. Allard, Works Department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mr. Allard claims that one of the mistakes made of welding cast iron by the steel metallic arc welding method is the practice of building up heavy sections or layers adjacent to the cast iron. When good fusion is obtained, the section of steel can be easily kept one-half that of the cast iron section required to give the necessary strength. It is evident that when stresses are high enough to warp the steel, it will pull from, warp or break the casting. The author claims it is not necessary to preheat castings using the metallic arc process. Article appeared October 17 and November 14 issues "Iron Trade Review."

Items of Interest

The Geo. D. Witcomb Company, manufacturers of Industrial and Railway Locomotives, has just completed a new factory addition to be used primarily for the manufacture of large oil-electric and large gear-drive locomotives.

Whitcomb is building modern motive power and has a complete line of gasoline, distillate, diesel, trolley, storage battery and oil-electric locomotives in sizes from 2 to 100 tons.

This expansion is due to the increased business of the company and at an early date they contemplate another addition to the office, as well as a plant extension during the early part of the coming year.

Edwin L. Wiegand Company, 7500 Thomas boulevard, Pittsburgh, Pa., have just issued a bulletin covering strip and space heaters. The bulletin covers a 24-hour quick shipment list. Copy of this bulletin may be had on request.

The Martindale Electric Company of Cleveland, O., are distributing a bulletin on Martindale Adjustable Growlers, external and internal. Copy of this bulletin will be sent to interested parties.

The Bull Dog Electric Products Company of Detroit, Mich., have just gotten out a new bulletin describing a new system of Electrical Distribution as represented by Bull Dog Bus-Duct and Trolley Duct. The bulletin describes some interesting installations and copy may be had on request.

The Brown Instrument Company of Philadelphia, Pa., have gotten out a new bulletin entitled "Why You Should Use Flow Meters." The bulletin describes "Twenty-four Ways In Which Flow Meters Reduce Steam Costs." Copy may be obtained by writing the above company.

IMPROVEMENT AND EXPANSION PROGRAMS

General improvement and expansion programs of the Iron and Steel Industry have been placed at $300,000,000. Practically all of these expenditures will be made during the year of 1930.

Illinois Steel Company, western subsidiary of the United States Steel Corporation, are working on a construction program estimated to cost between $150,000,000 and $200,000,000.

The American Steel & Wire Company will start at once on a new continuous billet and continuous rod mills at the Donora plant at a cost of $5,000,000.

Expansion programs for the Bethlehem Steel Company call for the expenditure of $50,000,000. Plans call for additions to the plate, sheet and roughing mills at Sparrows Point and increased roughing and billet capacity at Lackawanna, N. Y.

Wheeling Steel Corporation expansion programs call for an expenditure of approximately $5,000,000.

Expansion programs of Weirton Steel Company call for an expenditure of $7,000,000.

Inland Steel Company have appropriated approximately $15,000,000 for expansion programs. One-half of which will be completed by end of 1929 and the remainder during 1930.

The Pittsburgh Steel Company are building a $2,000,000 by-product coke plant.

The Apollo Steel Company expansion programs call for expenditure of $750,000.

American Rolling Mills Company have appropriated over $2,000,000 for extensions and improvements during the year of 1930.

Spang Chalfant & Company, Inc., are planning expansions and improvements which will cost $500,000.

The National Tube Company at McKeesport, Pa., are building a $20,000,000 seamless tube mill and other improvements.

The A. M. Byers Company are completing a $10,000,000 plant for production of wrought iron products. Plant is located at Ambridge, Pa.

The Trumbull Electric Manufacturing Company announces the formation of a new company, The A. G. Electric Manufacturing Company of Seattle, Wash., successor to the A. G. Manufacturing Company, in which organization the Trumbull Company has obtained a controlling financial interest.

The following men make up the Board of Trustees of the new company: A. E. Griswold, president and treasurer; W. E. Froude, secretary; J. H. Trumbull, vice president; F. T. Wheeler, vice president; H. Trumbull, assistant treasurer; S. S. Gwillim, assistant secretary, and A. S. Moody, trustee.

For the present there will be no change in the personnel of either the Trumbull Electric Manufacturing Company in its Pacific Coast representation or in the A. G. Electric Manufacturing Company. They will work together in an endeavor to serve the electrical industry of the far West on Safety Switches, Panel Boards, Switchboards and other accessories.

An announcement of promotions to the sales organization is made this month by Square D Company, of Detroit, Milwaukee, and Peru, Ind.

J. J. Mitchell, previously Branch Sales Manager in Cleveland, O., has been transferred to the general offices in Detroit and placed in charge of all of the company's panelboard sales.

M. W. Parmalee, previously Square D sales representative in Cleveland, will succeed Mr. J. J. Mitchell.

The addition to the Square D sales organization is R. C. Thompson, formerly of the Moock Electric Supply Co., Canton, O., who succeeds Mr. Parmalee as sales representative in Cleveland.

The U. S. Electrical Mfg. Co. of 200 East Slauson avenue, Los Angeles, announces the shipment of 155 electric motors to be installed in the first of several coal breakers being built by the Stone & Webster Engineering Corporation of Boston for the Philadelphia & Reading Coal & Iron Co. of Philadelphia.

SYNCHRONOUS MOTOR APPLICATION FOR SEAMLESS TUBE MILLS OF THE NATIONAL TUBE COMPANY

The largest single installation of synchronous motors in steel mills will soon be made at the National Works of the National Tube Company, McKeesport, Pa. The six large synchronous motors that will be used for driving two seamless tube mills are being manufactured by the Westinghouse Electric and Manufacturing Company. One of these mills will have installed in it two 3500 hp., synchronous motors and one 2000 hp., synchronous motor. The two 3500 hp. motors will drive piercing mills and the 1000 hp. motor will drive the tube rolling mill. A second mill will have installed in it two 2000 hp. synchronous motors and one 1000 hp., synchronous motor. The two 2000 hp. motors will drive piercing mills and the 1000 hp. motor will drive the tube rolling mill.

The machines will be designed with enclosing covers so as to prevent dirt and dust from getting into the motor windings. These enclosing covers will be connected to an air filtering equipment which will clean the air and force it into the motor at a pressure of about 5/8 ounce.

Another special feature of the design of the machines will be that they will have high peak load rating. Each of the machines is designed to carry 350 per cent load at frequent intervals. Their windings will be insulated for high temperatures and their load carrying capacity will be far in excess of any machine that has been used for driving any similar mill.

Each of the machines will have a field sustaining relay which will sustain the strength of the field under high load conditions so as to permit it to carry peak loads which are frequently required on these types of mills.

When the installation is completed it will be the first seamless tube mill installed in the McKeesport Plant. The National Tube Company, who are the largest manufacturers of seamless tube in this country, have not utilized the McKeesport Plant for seamless tube production, as only the plants at Gary, Ind., Lorain, O., and Elwood City, Pa., have been producing all of their seamless tube products. When this installation is made, however, the National Works will have a larger installation than any of the other plants except the Lorain Plant located in Lorain, O.

The Great Lakes Steel Corporation of Detroit, Mich., have contracted with The Chapman-Stein Company for all their continuous billet heating furnaces. This order consists of two furnaces, each designed for 45 tons per hour, for their 20" Mill, and one furnace designed for 50 tons per hour for their 14" Mill.

The Weirton Steel Company have also contracted for a new continuous slab heating furnace for their 48" wide strip mill at Weirton. This furnace will make a total of five continuous slab heating furnaces which The Chapman-Stein Company has built for the Weirton Steel Company.

The Otis Steel Company have just purchased an installation of Chapman-Stein patented one-way-fired soaking pits. These pits will be equipped with Blaw-Knox Preheater.

The Bourne-Fuller Company have contracted for the same type of soaking pits for their Upson Works, at Cleveland, O.

The Corrigan, McKinney Steel Company, of Cleveland, have contracted for a 7-hole installation of the same type of pit equipped with Chapman-Stein Refractory Tile Recuperators.

The Ford Motor Company has contracted with the Freyn Engineering Company for the installation of a Freyn-Design Blast Furnace Charging Control System on one of the River Rouge Blast Furnaces.

The Carnegie Steel Company has purchased a Freyn-Design Continuous Stock-Line Recorder for installation at its Edgar Thomson Works.

Another Freyn-Design Continuous Stock-Line Recorder has been purchased by the Sloss-Sheffield Steel & Iron Co. of Birmingham.

Illinois Steel Company has purchased two more Freyn-Design Continuous Stock-Line Recorders for use at its South Works.

CHOKE COILS YIELD TO TRANSMISSION LINE TESTS

Experiments with Artificial Lightning Show that Choke Coils, Used Thirty Years in Lightning Protection Work, are of no Assistance With Modern Equipment

For more than thirty years it has been standard practice in the electrical industry to use choke coils in connection with lightning arresters for the protection of apparatus and transmission lines against damage caused by lightning and high voltage surges. Mathematical calculations showed, in general, that such coils assisted the lightning arresters by reflecting and retarding the incoming voltage waves.

Now, as a result of the development of the artificial lightning generator, the cathode-ray oscillograph or millionth-of-a-second camera and other new devices for the production and measurement of lightning-like voltage surges, it has been determined that choke coils are not useful accessories to lightning arrester installations; and the manufacture and sale of such coils has been discontinued by the General Electric Company.

"There have been several mathematical studies of the action of choke coils on overhead circuits, and there is a fairly general agreement on the methods of calculations," says V. E. Goodwin, engineer of the lightning arrester department of the General Electric Company. "These mathematical equations have been based on certain assumptions regarding wave fronts and the instantaneous equivalent circuits and constants of the transformers, etc. With certain assumptions it can be shown that the choke coil has merit, while with other assumptions the reverse may be indicated. The assumptions were subject to too much uncertainty to make the mathematical treatments conclusive. Actual operating experience bearing on the merits of the choke coils has contributed nothing conclusive, some observations in practice seeming to substantiate and other seeming to oppose the prevailing theories.

"The true value of the choke coil could not be

determined until exacting tests could be made on an actual transmission line. The development of portable lightning generators for creating known lightning transients on the line and portable cathode-ray oscillographs for recording the voltage current and time at any point of the circuit, have made possible a series of tests to define the performance of the choke coils with different transient wave forms imposed.

"These recently completed tests using wave shapes corresponding to the range of actual lightning waves recorded during the past two years, show that the choke coil does not aid the performance of modern arresters and does not reduce the stress on the transformer or other apparatus and under some conditions may even be detrimental to the service. These tests are quite conclusive, so that the choke coil is no longer considered as a useful accessory to any lightning arrester installation."

In the last few years a large amount of information has been collected with respect to lightning surges on transmission lines. These studies showed that perpendicular waves—reaching maximum value practically instantly—rarely if ever occur, and indicated that the majority of impulses due to lightning will not reach their crest voltages in a time less than one microsecond, or millionth of a second. Information is now available showing the possible duration and rate of decay of such lightning transients. Having this information, it is now possible to apply "man-made lightning" to transmission lines with considerable assurance that the effects will in general be the same as could be caused by natural lightning.

Since the cathode-ray oscillograph has been available, much information has been gained from laboratory tests; but it was felt, particularly in the case of lightning arresters, that until high-voltage surges were placed on full-sized transmission lines and their effects studied with the cathode-ray oscillograph, the data could not be used with complete assurance. During the summer of 1928 such a study was begun on the Turner Falls 66,000-volt transmission line into Pittsfield, Mass., using a portable impulse generator giving an open-circuit potential of 400,000 volts. The work of the summer of this year included a study of the operation of the choke coil when connected to a transmission line with arrester and transformer connected as in service. All of the tests were made at the Silver Lake Station of the Pittsfield Electric Company, where a two-circuit transmission line belonging to the Turners Falls Power and Electric Company terminates. This line has strings of six insulators and has a ground wire at the top of the steel towers. The impulse generator was located at Tower 279, 5.77 miles from the Silver Lake Station where the oscillograph was located.

The object of the investigation of choke coils was three-fold:

(1) To determine whether the operation of the modern valve-type lightning arrester is improved by the use of a choke coil; (2) to find out whether the present choke coil is harmful; and (3) to determine what could be done to improve any beneficial action of the choke coil, or to mitigate its harmful action if such was found to exist.

The conclusions reached by the investigation, as pointed out by K. B. McEachron of the lightning arrester engineering department of the General Electric Company, are:

The use of inductance between a lightning arrester and transformer, even though the inductance is of much larger value than that employed with standard choke coils, does not help the operation of the arrester to an appreciable degree.

Without an arrester connected, a choke coil having an inductance of the order now used in practice will not oscillate with a transformer having a capacitance of the order of that used in the tests.

When a choke coil of the magnitude used in the tests is connected between the lightning arrester and transformer winding, oscillations are likely to occur, and their crest potential may exceed that across the arrester terminals.

The use of choke coils in combination with a transformer and arrester should be discontinued in order that an arrester such as the oxide-film arrester may give its best protection.

With high-voltage arresters the resistance to ground will be several times that of the arresters used in the test, which will tend to reduce the possibility of oscillation.

Choke coils may be of slight benefit with arresters whose breakdown voltage is several times the IR drop. This benefit would be present only with very steep waves.

Choke coils of the usual inductance when used in combination with a transformer, without an arrester, do not protect the transformer, nor are they harmful.

Obituaries

JOSEPH W. DONNER

Joseph W. Donner, 35, vice president in charge of operations of the Donner Steel Co., Inc., Buffalo, and son of William H. Donner, its president, died November 9 at his home in Middlesex road, that city, following an illness of several months. He was graduated from Princeton University in 1917 with a degree of Litt. B. and immediately entered the employ of the Donner company at Buffalo, beginning as an inspector and mastering all details of the business. He became engineer of tests, then assistant superintendent and in January, 1926, was appointed general superintendent. He was elected vice president in May, 1929. He had been a director of the company since 1917.

SAMUEL BERTRAM SHELDON

Samuel Bertram Sheldon, 61, president of the Minnesota Steel Company, Duluth, subsidiary of the United States Steel Corporation, since late 1927, died unexpectedly at his home in that city, November 22. He was well known in the steel industry both for his inventions and for his contributions to its expansion, credit being given him for directing the construction of about 90 per cent of the original Lackawanna Steel Company plant at Buffalo and for 80 per cent or more of the present plant of the Minnesota Steel Company. His inventions include an automatic gas producer; he also developed a continuous process for manufacturing by-product coke.

AIR PREHEATING

How Much Can You Afford to Pay For It?

The heat recovered from the waste gases and returned to the furnace — has a certain value to you.

The improvement in combustion and furnace conditions due to preheated air — has a further value to you.

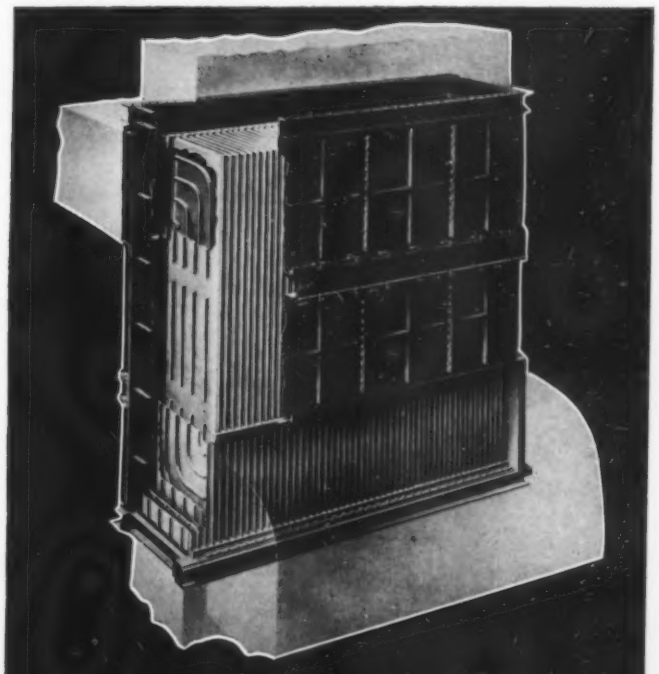
These two items may represent as much as 10% improvement in overall plant efficiency and for this improvement you can afford to pay a certain price.

— But complications of plant operation and the maintenance of masses of moving parts — need not be part of that price.

The C-E Plate Type Air Preheater is of the direct heat transfer type. There are no moving parts — nothing to wear out — nothing to get out of order or adjustment.

• • •

A catalog illustrating and describing the C-E Air Preheater is available. Would you like a copy?



The C-E Air Preheater is of the plate type and employs the counter-flow principle which insures maximum heat transfer from the waste gases to the combustion air. Conveniently located doors provide ready access to the gas passages for cleaning.

COMBUSTION ENGINEERING CORPORATION

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A Subsidiary of
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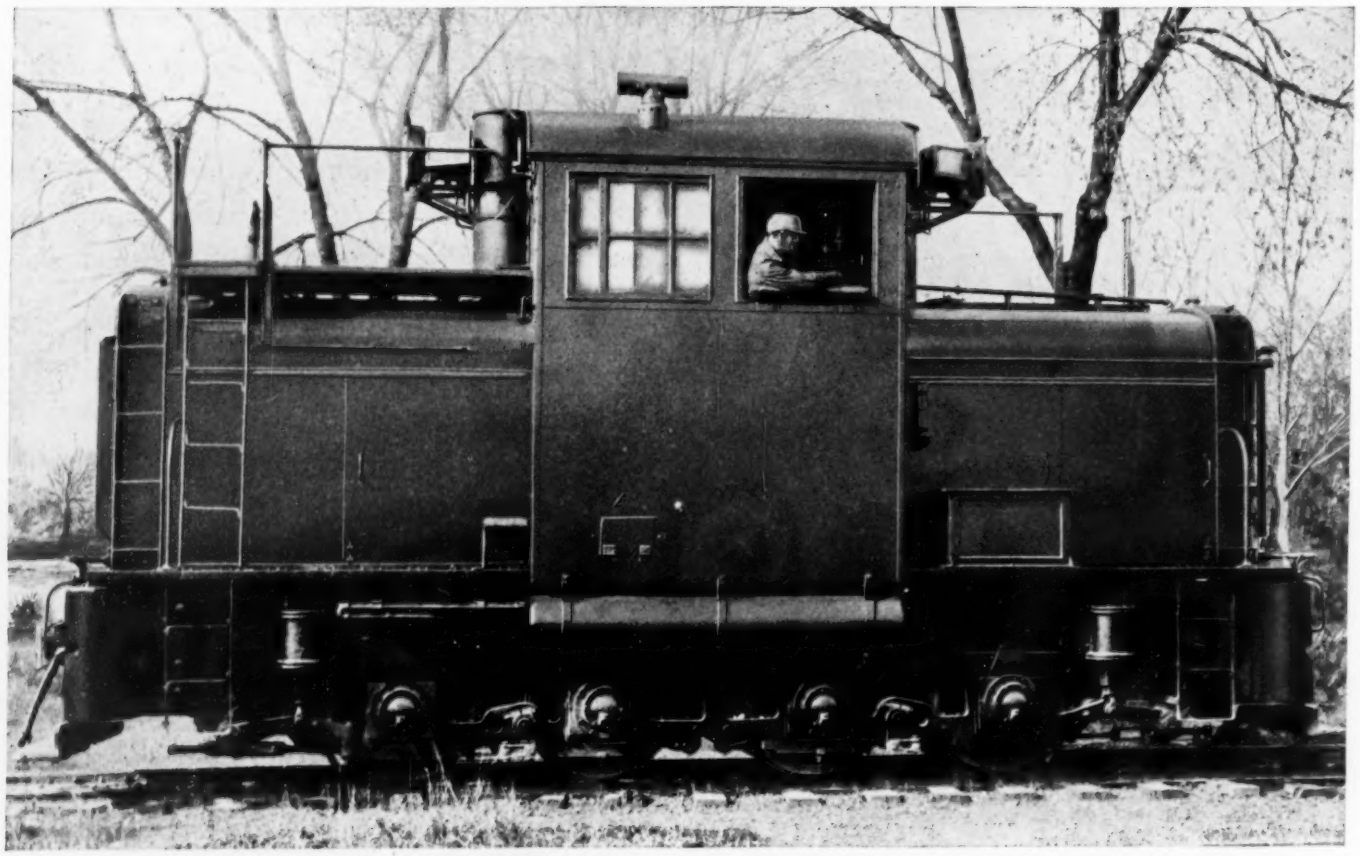
MODERN MOTIVE POWER *for* STEEL MILLS



View of 80-ton Oil-Electric Locomotive recently completed for large Railroad in the Central West.

SPECIFICATIONS

Gauge	4′ 8½″
Engine	
Cylinders, number	Six
Cylinders, diameter and stroke	7¾″ x 8½″
Cylinders, type	4 cycle
Nominal Horse Power	300
No. on Locomotive	Two
Total H. P. on Loco.	600
Electric Motors, number	Four
Electric Motors, type	Westinghouse #584-D-2
Electric Motors, voltage	500
Main Generator, type	Westinghouse #181-C-3
Driving Wheels, diameter	38″
Journal Bearings	Timken
Wheel Base, rigid	13′ 6″
Wheel Base, total	13′ 6″
Length from center to center of couplers	29′ 6″
Length over cab	8′ 0″
Height over all	15′ 2″
Capacity of fuel tanks	400 U. S. Gal.
Weight on driving wheels	160,000 lb.
Weight total engine	160,000 lb.
Starting tractive force, maximum	40,000 lb.
Maximum, with sanded rail	48,000 lb.

Built in sizes 15 to 100 tons, 4 and 8-wheel types. Details and data are available.

George D. Whitcomb Company

Locomotives

3 to 100 Tons

Rochelle, Illinois.

WRITE FOR BOOKLET "LOCOMOTIVE WITH INTERNAL COMBUSTION ENGINE DRIVE."

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PITTSBURGH, PA.
C. W. Chappelle, 1008 House Bldg.
ST. LOUIS, MO.
B. L. Beck, 1005 Fed. Com. Tr. Bldg.
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J. M. Hawkins, 539 Free Press Bldg.
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Keep Production Flowing
Reduce Operating Costs
Minimize Maintenance
throughout the steel mill,
with equipment operating on

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PRODUCT OF GENERAL MOTORS

Wherever installed on mill tables, motors, cars, cranes and all other equipment, smooth rolling Hyatts transmit power without effort or waste. Practically frictionless, they avoid the sticking and drag of plain bearing surfaces.

Equipment lasts longer when rugged Hyatts are employed. Immunity from bearing breakdowns insures faster, smoother, continuous production. Attention is confined to infrequent lubrications. Labor and maintenance costs are negligible.

Hyatt Roller Bearings are built to withstand the terrific pounding experienced in steel mill service. Let us submit designs and estimates for your equipment, either new or changeover.

Throughout all steel mill applications, especially where service demands are extreme, you will find that the Hyattway is the Right Way.

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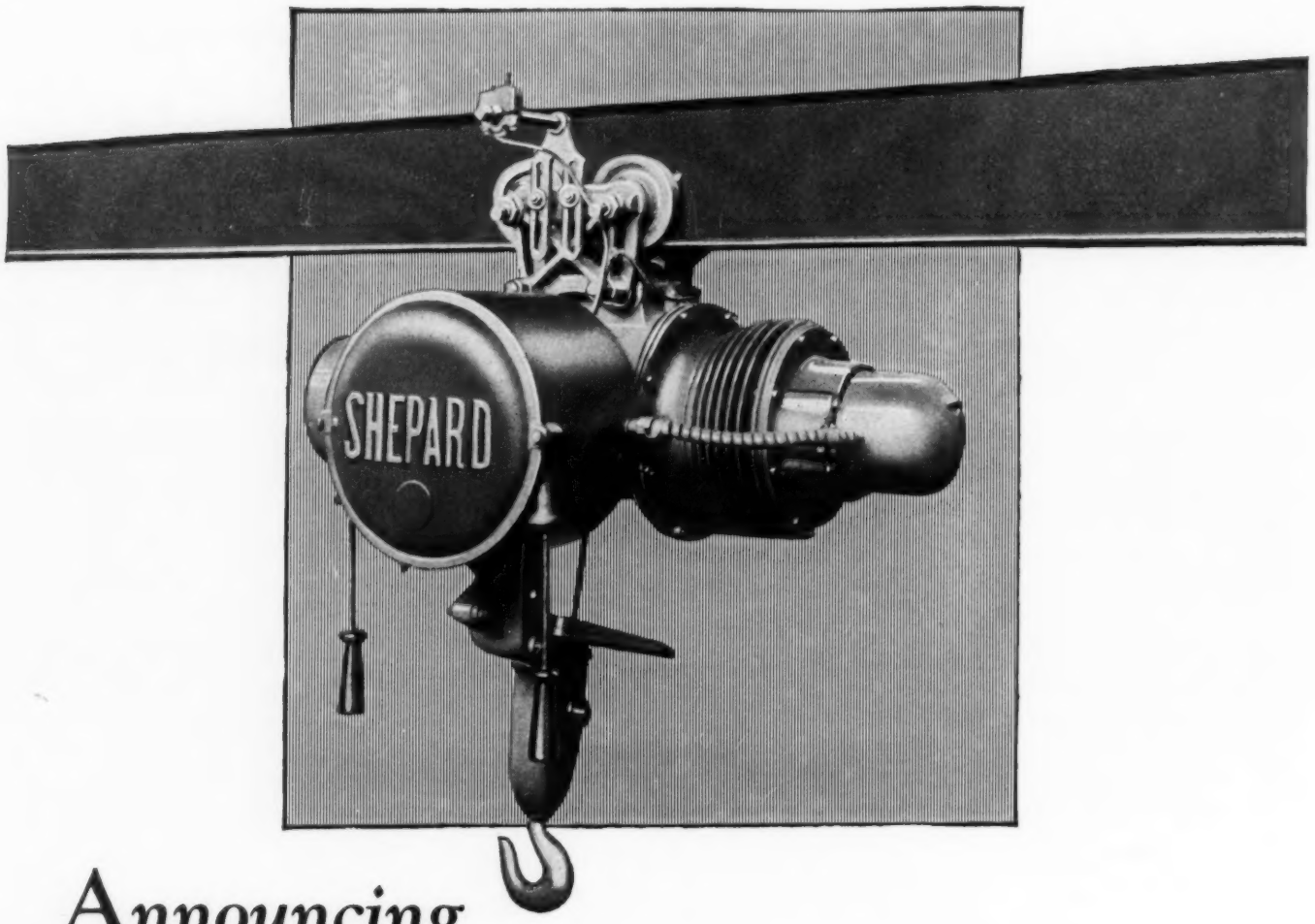
Newark Detroit Chicago Pittsburgh Oakland



Announcing the Shepard Compact Hoist

Consider these features...

1. Sectionalized construction provides a Compact Hoist specially suited to the job...without the cost of special manufacture.
2. Enduring strength is wrought into every detail of the all-steel Shepard Compact Hoist.
3. All moving parts operate in an oil bath, assuring proper lubrication at all times...automatically.
4. Heat treated gears are used in the planetary train.
5. Specially designed motors afford a sure start and a quick stop.
6. Response to controls is instant...positive.

In every detail the Compact Hoist represents the finest that Shepard has produced. It is fortified throughout with the very best of steel...and proportioned to assure the utmost strength per pound of weight.

Safety load block...improved electric brake and limit switch...cooling fins on the load brake...heat treated steel gears...special motor...these are some of the features which Shepard has added to make the new Compact Hoist veritably "a hoist that won't grow old".

Shepard representatives are located in the principal cities from coast to coast. They will be glad to give you complete information.

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Member EMA ELECTRIC HOIST MANUFACTURERS ASSOCIATION

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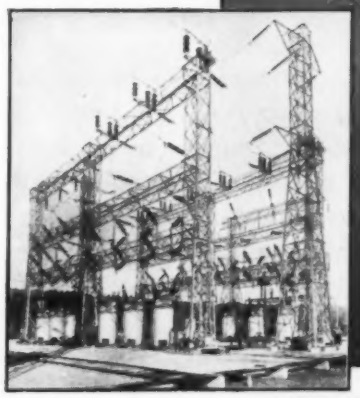

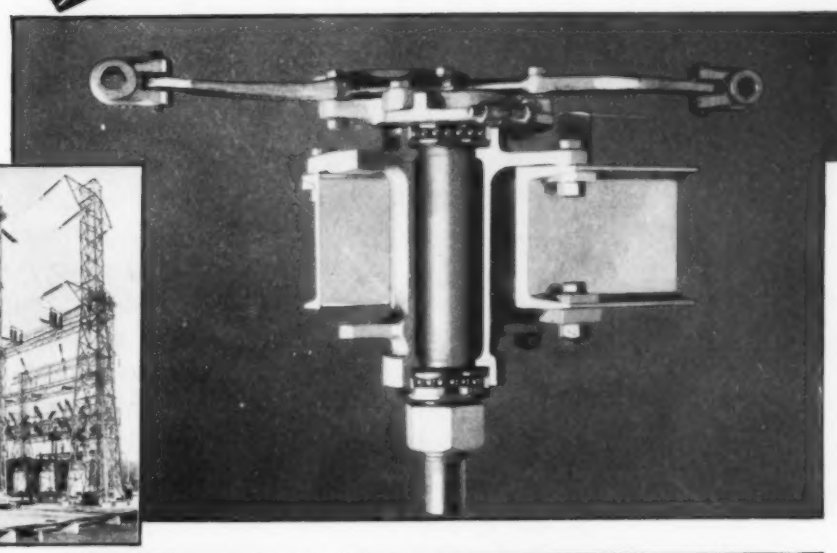

At left: *Sectional view of main bearing of Hi-Voltage Switch showing Monel Metal ball bearings which require no lubrication. Monel Metal bolts are also supplied if specified. Mfd. by THE HI-VOLTAGE EQUIPMENT CO., Cleveland, Ohio.*

At extreme left: *Installation of Hi-Voltage Air Break Switches which are built with Monel Metal ball bearings as standard equipment.*

HI-VOLTAGE

switches have ball bearings of...

MONEL METAL

The Monel Metal ball bearings used in all Hi-Voltage switches eliminate the need for any lubrication.

Monel Metal is used for these ball bearings and many other important parts of well-known outdoor switching equipment because it affords a combination of properties not found in any other material.

Monel Metal will not rust. It is free from corrosion-cracking. It retains its high strength through extremes in temperatures. It is *not* subject to fatigue failures.

To insure the dependability of outdoor electrical equipment, specify Monel Metal bolts, nuts, springs, pins—for parts which must not fail.

SEND FOR BOOKLET—"BOLTS THAT WILL NOT FAIL"

Monel Metal is a technically controlled Nickel-Copper alloy of high Nickel content. It is mined, smelted, refined, rolled and marketed solely by The International Nickel Company, Inc. The name "Monel Metal" is a registered trade mark.

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HERE'S workable temperature for all of those mean, hard-to-heat, out-of-the-way places . . . . that spells guarantee against costly production delays. Take the "too cold to work out there" excuse by the back of the neck and get rid of it for good. *Chromalox electric heaters* are economical, adaptable, *safe* and dependable. Easily installed. Always ready. Perfect control. No waste. The booklet has an interesting story for you. Send for it. No obligation.

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COMPLETE ELECTRIC HEATERS

. . . . check these places in your plant *now!*

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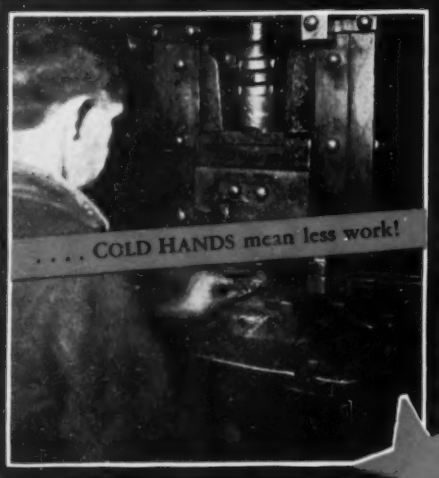
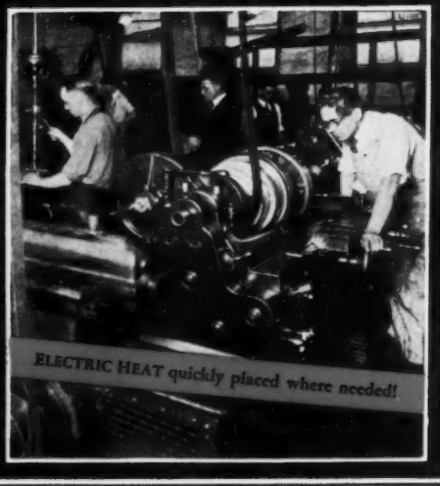
★Over 150,000 Chromalox Strip Heaters now heating cars on over 220 railways —*toughest kind of work!* Railway Utility Co. of Chicago, sole distributor for railroad and street car field in U.S. & Canada.





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YES, without obligation, send me a copy of this heating equipment booklet (C-108) and tell me how to properly heat a space used for _____ft. long _____ft. wide _____ft. high, having (no. of) _____doors_____windows.

Signed_____ Position_____

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Revolutionary new entirely automatic Lubricating System *meets high approval of Engineers* . . . .

Because the new Keystone Pneuma-Lectric System does *all* of the following remarkable things—and can do them on *your* machinery—it merits your serious and immediate consideration:

1. **Eliminates all repairs and shut-downs due to imperfect lubrication.**

2. **Reduces power consumption by at least ⅓ to ½.**

3. **Increases bearing life by a wide margin.**

4. **Cuts lubrication bills 25% to 50%.**

5. **Can be adapted to many types of machines in all industries.**

6. **Soon pays back its reasonable cost by the tremendous savings it effects.**

See our exhibit, space No. 3, National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, N. Y., December 2nd to 7th.

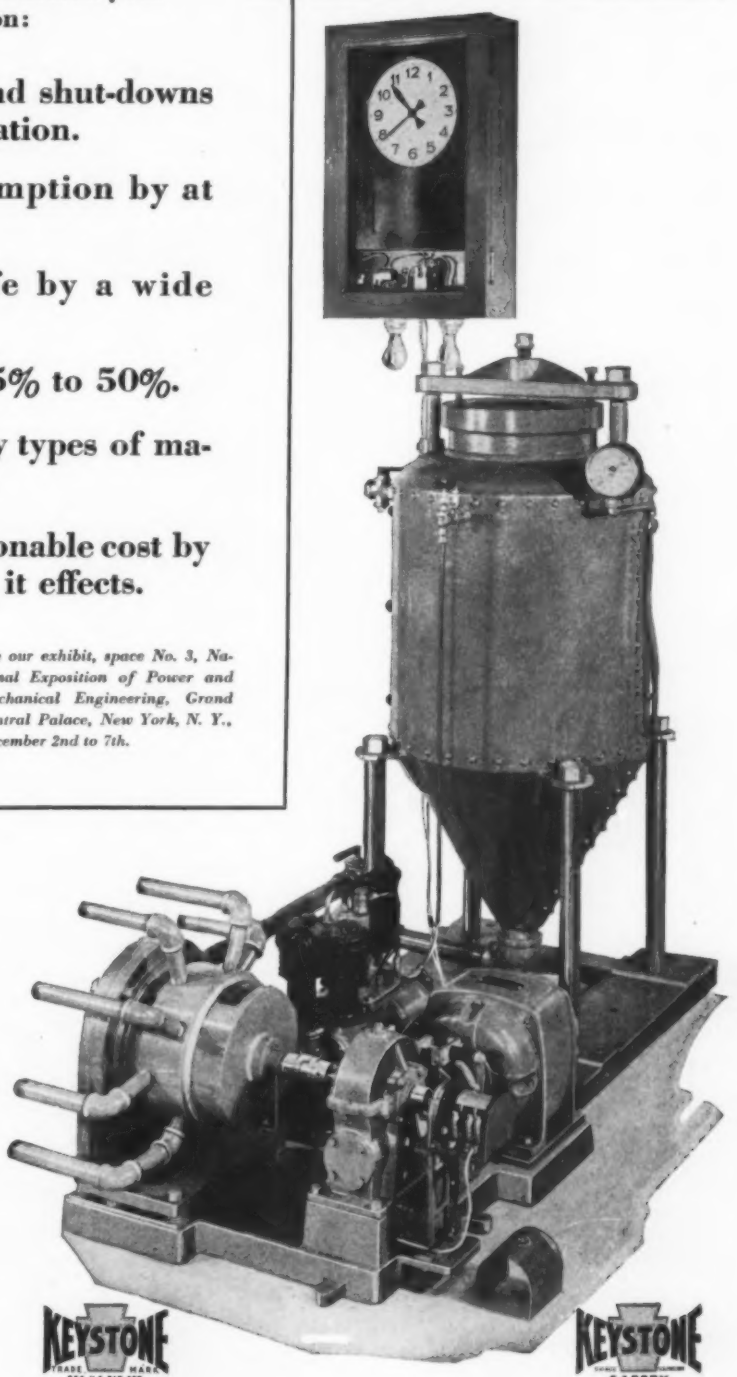
It may seem almost incredible that any device can effect the economies named above. But the Pneuma-Lectric System—the fruit of years of research work in the laboratories of the Keystone Lubricating Co.—effects them all! And without manual work except the occasional filling of the grease tanks!

Engineers who have thoroughly tried out this new system of lubrication have expressed themselves as very well pleased with it. The Lukens Steel Company, makers of the largest steel plates in the world, have adopted it; and many other installations are already under way.

Don't fail to get the full facts. You owe it to yourself to do so. Write for particulars.

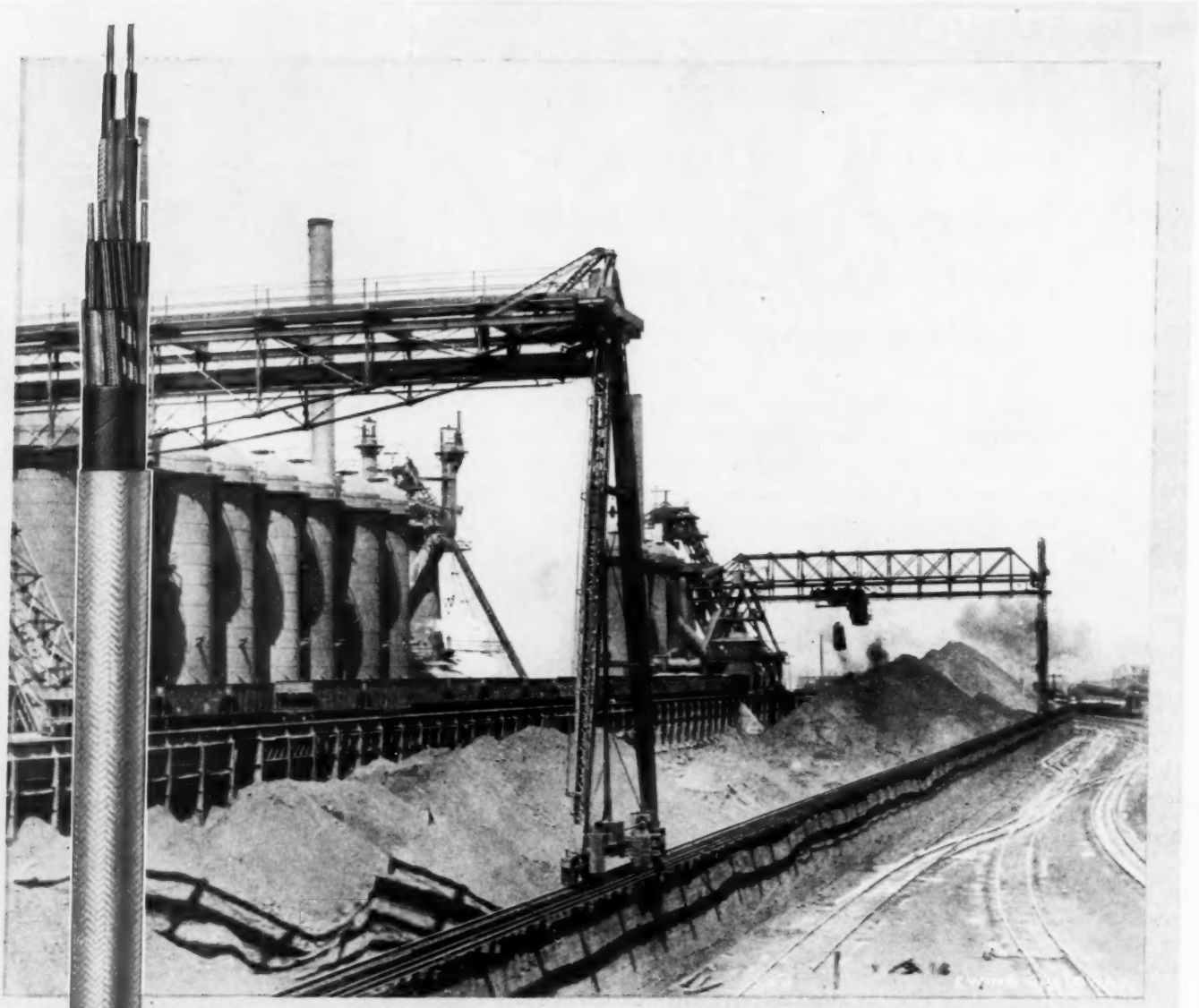
KEYSTONE LUBRICATING CO.
21st, Clearfield & Lippincott Sts.
Philadelphia, Penna.
Established 1884

KEYSTONE
Pneuma-Lectric
LUBRICATING
SYSTEM



KEYSTONE TRADE MARK REG. U.S. PAT. OFF. GREASE

KEYSTONE SAFETY LUBRICATING SYSTEMS



Electric Gantry Cranes Handling Ore Into Blast Furnaces at a Large Steel Mill

You can specify ***OKONITE QUALITY***
Only by specifying ***Okonite***

A cook book is a collection of food specifications. Some cook books are famous for their recipes—but it always requires the skill of an experienced cook to prepare good food.

Any experienced engineer can write cable specifications that explain his demands, but no engineer can write OKONITE QUALITY, which is based on a half century of cable making, into any mere specification.

OKONITE QUALITY can be insured only by specifying and buying OKONITE.

OKONITE QUALITY Cannot be Written Into a Specification

THE OKONITE COMPANY

Founded 1878

THE OKONITE-CALLENDER CABLE COMPANY, Inc.

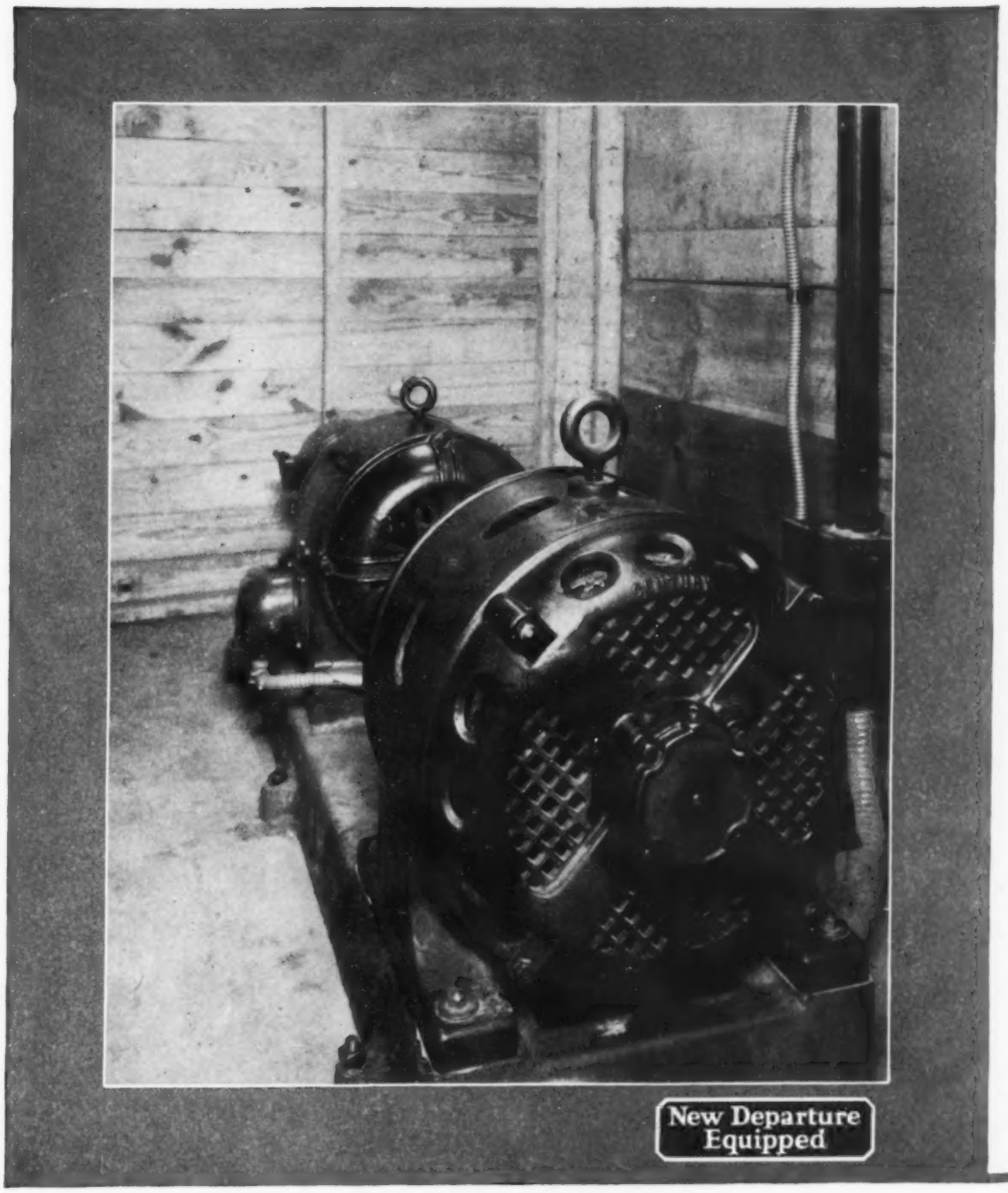
FACTORIES: PASSAIC, N. J. PATERSON, N. J.

SALES OFFICES: NEW YORK CHICAGO PITTSBURGH
ST. LOUIS BOSTON ATLANTA BIRMINGHAM
SAN FRANCISCO LOS ANGELES SEATTLE DALLAS

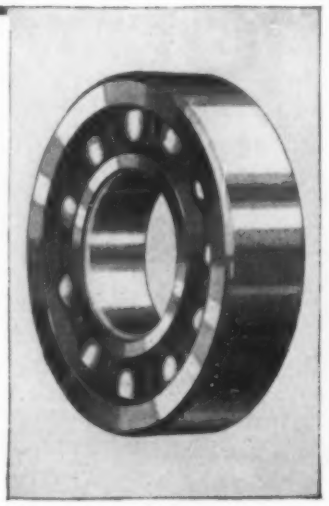
Novelty Electric Co., Philadelphia, Pa.
F. D. Lawrence Electric Co., Cincinnati, O.
Canadian Representatives:
Engineering Materials, Limited, Montreal
Cuban Representatives:
Victor G. Mendoza Co., Havana

OKONITE

Okonite Products
Okonite Insulated Wires and Cables
Varnished Cambric Cables
Okonite Insulating Tape
Manson Friction Tape
Okonite Cement
Okocord
Okoloom
Okonite-Callender Products
Impregnated Paper Cables
Super-Tension Cables
Splicing Materials



YOU will find New Departure-equipped Century motors in all industries. You will find praise for their performance, too . . . . praise justly earned, for they are electrically efficient and mechanically accurate. They run for months between each application of lubricant. New Departures reduce burnouts by eliminating one of their prime causes, de-centered armatures. Being practically frictionless and wear-proof, New Departures never need readjustments throughout their long life. The New Departure Mfg. Co., Bristol, Connecticut. o o o NOTHING ROLLS LIKE A BALL

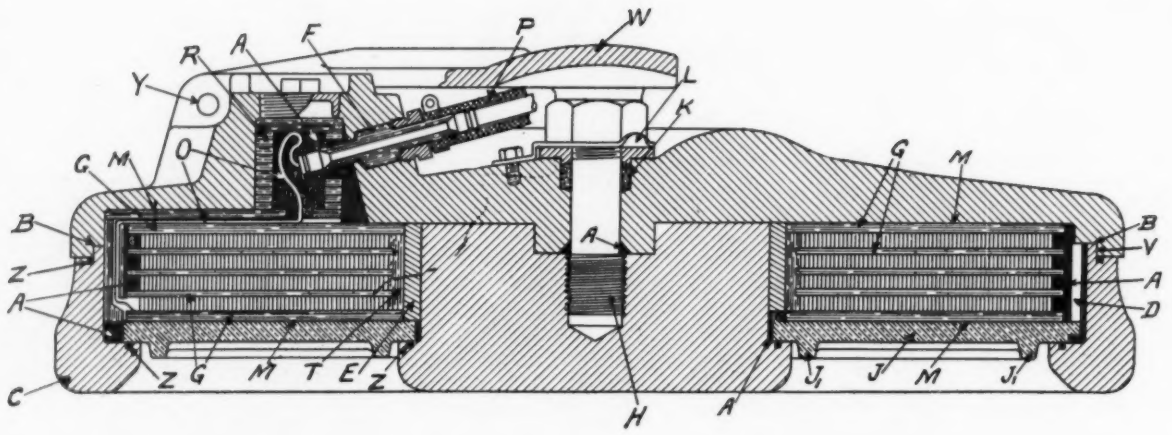


NEW DEPARTURE
BALL BEARINGS

1262

TWO NEW REASONS FOR

OHIO MAGNET RELIABILITY



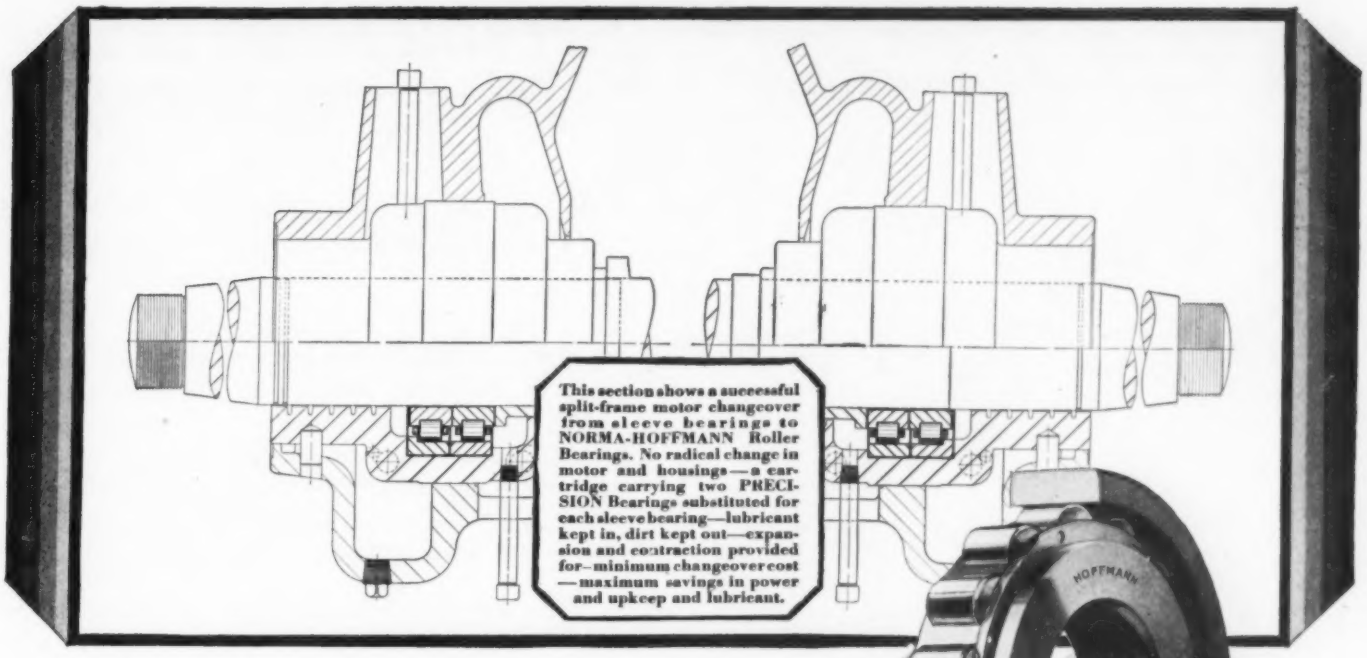
Ribs "J" will prevent complete wear-down of Center Pole or Outer Ring with resulting sag of bottom plate and eventually a ruined coil.

"Y" will prevent loss of protecting shield "W," hence protection of terminals and leads is preserved.

Two very important improvements.

OHIO reliable MAGNETS

The
Ohio Electric & Controller Co.
5907 Maurice Avenue
Cleveland, Ohio


This section shows a successful split-frame motor changeover from sleeve bearings to NORMA-HOFFMANN Roller Bearings. No radical change in motor and housings—a cartridge carrying two PRECISION Bearings substituted for each sleeve bearing—lubricant kept in, dirt kept out—expansion and contraction provided for—minimum changeover cost—maximum savings in power and upkeep and lubricant.
HOFFMANN

MAKING STEEL MILL MOTORS BETTER *by a simple changeover!*

DUST, dirt, heat, heavy loads, sudden load changes—these are what make life hard (and short) for steel mill motors. Sleeve bearings cannot stand it—long. Good anti-friction bearings, properly mounted, increase motor efficiency, lengthen motor life.

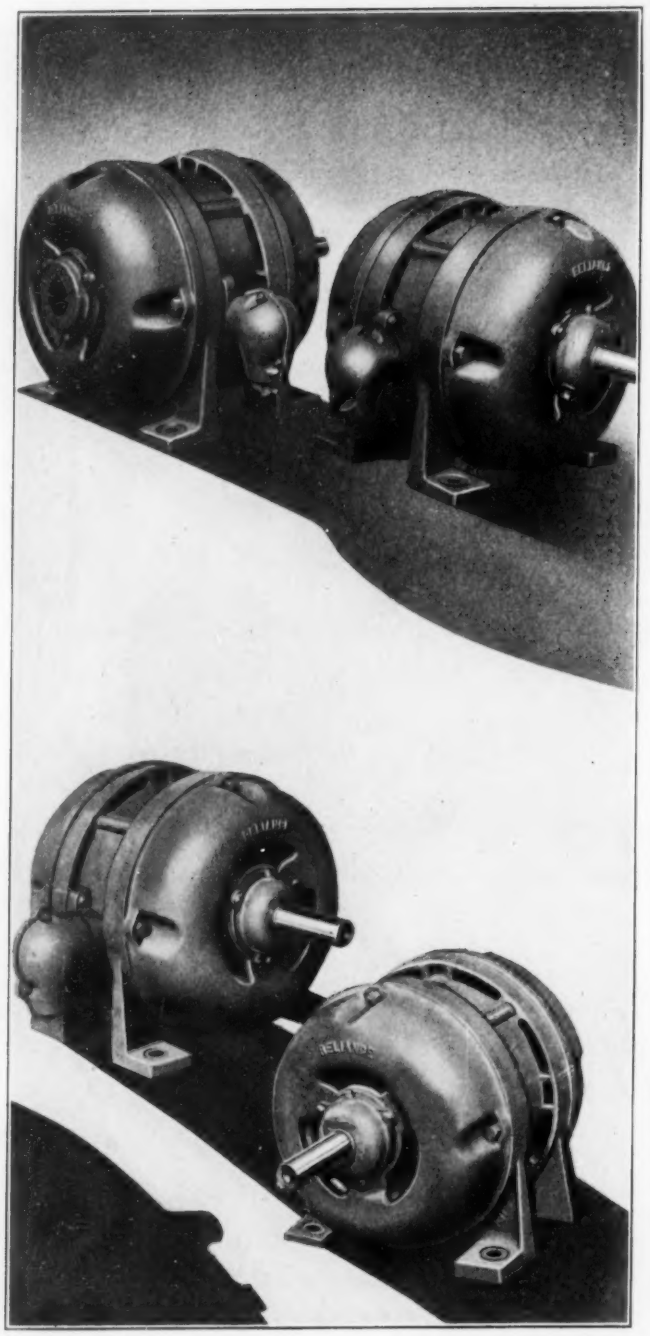
NORMA-HOFFMANN Precision Roller Bearings are standing up in steel mill service with the same rugged resistance they have shown in other hard duties.

They are earning worth-while dividends in the savings they effect.

Let our engineers help you in selecting the right bearings and in mounting them properly.

NORMA-HOFFMANN
PRECISION BEARINGS

NORMA-HOFFMANN BEARINGS CORPORATION STAMFORD, CONN., U.S.A.



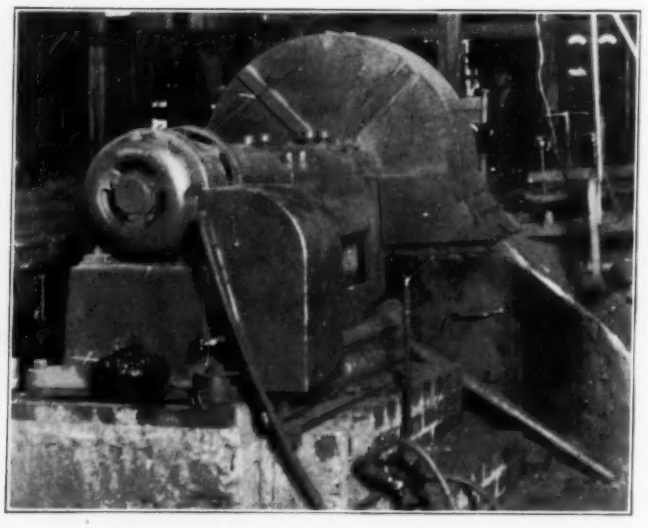
Get still better service from your motors

Reliance Offers An Improved Method of Protection Which Insures Longer Life With Less Maintenance

Many open-type induction motors in the steel and tube mills are showing excellent records for steady operation even under unfavorable conditions. In such cases, however, users are frequently taking long chances and incurring extra expense for inspection and maintenance which can now be avoided.

The Reliance method of enclosing with fan-cooling makes it possible to give complete protection to all vital parts, without complications which mean excessive cost. The common trouble makers—dust, chips and oil—cannot get in to clog air gaps and damage the windings. You can mount the motors any place and be sure that they will stay clean inside.

Learn the full value of this protection by putting an enclosed fan-cooled Reliance Motor to work on the dirtiest job you can find.



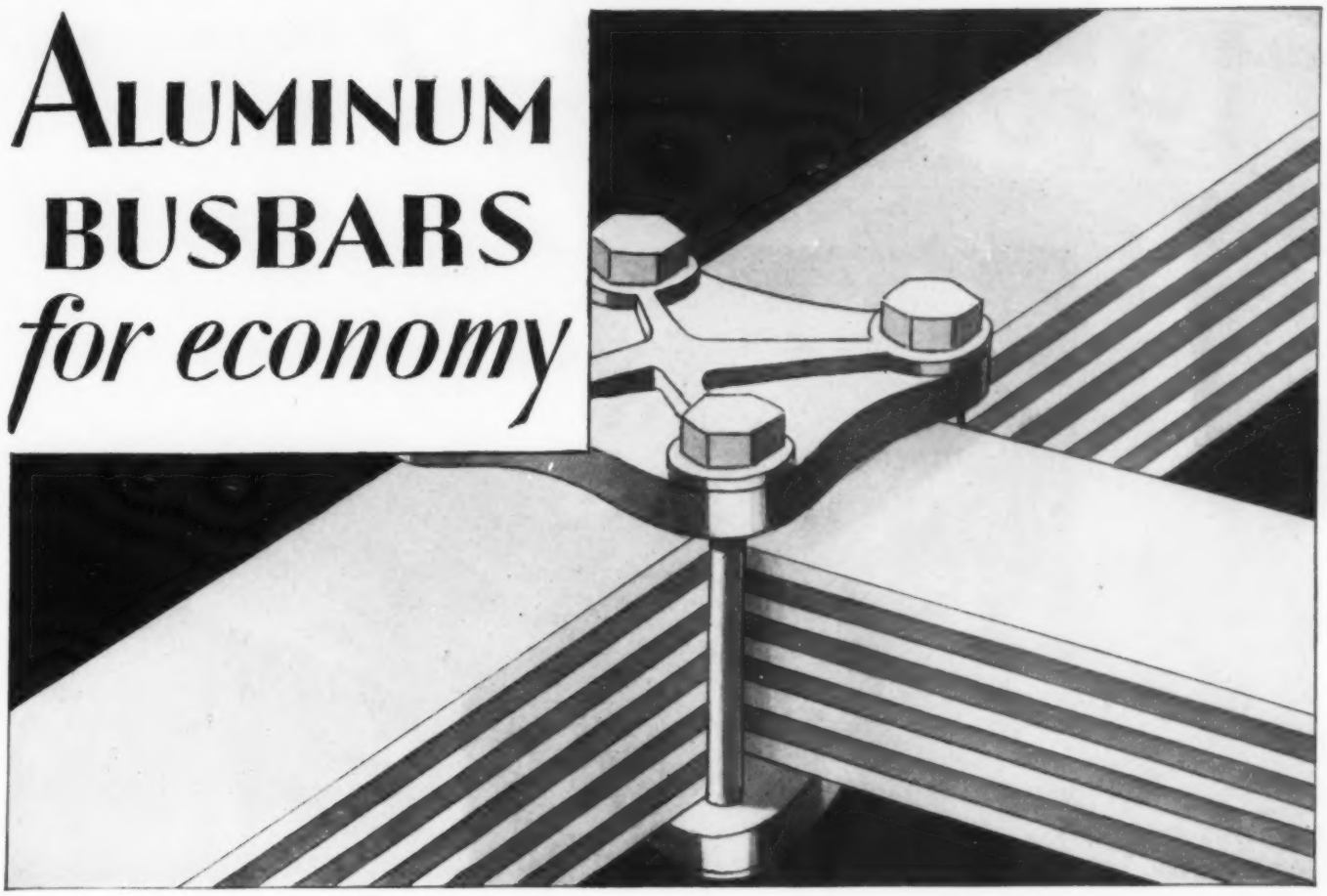
It is on jobs like this that you can expect better service from enclosed fan-cooled Reliance Motors. This motor is driving a hot saw in a tube mill.

Reliance Electric & Engineering Co.,
1080 Ivanhoe Rd., Cleveland, Ohio.

BRANCHES: Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, New York, Philadelphia, Pittsburgh, St. Louis.

RELIANCE A-C D-C MOTORS
with Ball Bearings

ALUMINUM BUSBARS *for economy*



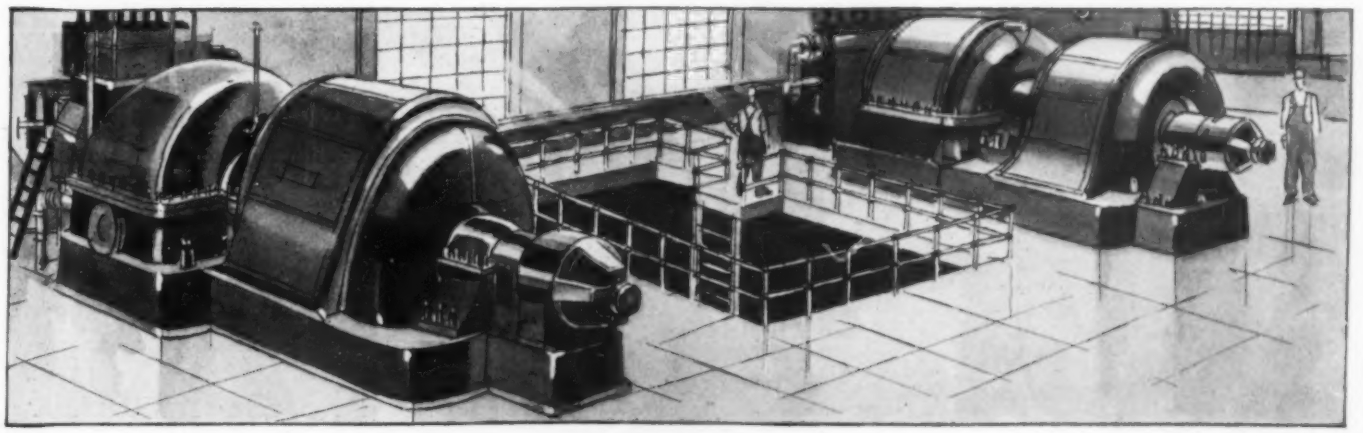
FOR years the most important nations of Europe have standardized on Aluminum Busbars as most economical and satisfactory for transmission purposes. In this country the steadily widening use of Aluminum Busbar clearly shows the way it is regarded by American engineers.

The booklet, "Aluminum Busbars," contains tables of weights, carrying capacities and physical properties, with installation photographs. Please send for your copy.

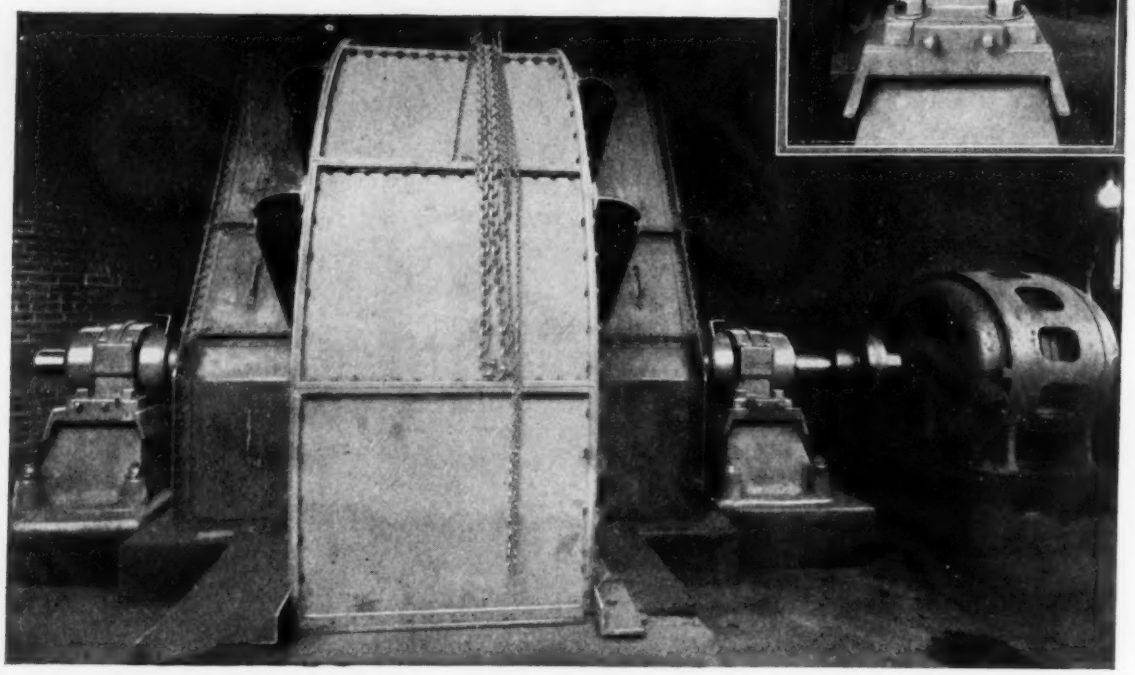
ALUMINUM COMPANY OF AMERICA
2461 Oliver Bldg., Pittsburgh, Pa.
Offices in 19 Principal American Cities

ALUMINUM

Busbar



Dividends!



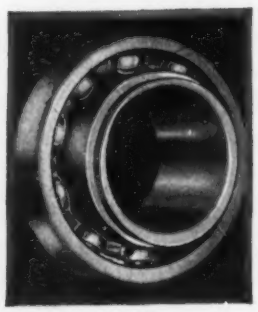
paid by GIANT FAFNIR PILLOW BLOCKS to the E. & G. Brooke Iron Co....

Brooke's whole production schedule rests on these two huge Fafnir Pillow Blocks supporting the shaft of the 100 inch fan. And the plant has run 24 hours a day, since the Fafnirs were put in. Before that, shut-downs from plain bearing breakdowns were "all in the day's work."

The dividends paid by Fafnirs offset their cost in about a year . . . now they have a towering balance to their credit. They reduced power consumption . . . increased *and stabilized* production . . . ended maintenance labor on the fan . . . and save gallons of oil every month. Fafnirs are greased once or twice a year, and beyond that they take care of themselves. Ashes, dust, and grit are kept out. Lubricant is kept in.

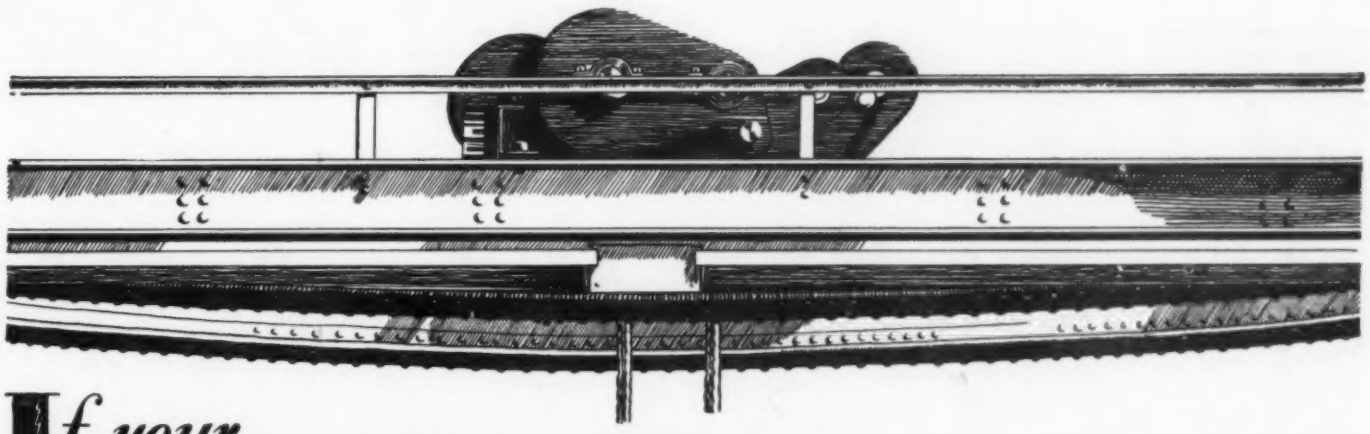
Wherever production schedules depend on bearings, fortify the crucial points with Fafnirs. You will find—as Brooke has found—that Fafnirs "do all they're guaranteed to do—and more!"

THE FAFNIR BEARING CO., NEW BRITAIN, CONN.
Newark .· Chicago .· Cleveland .· Detroit .· Philadelphia .· Milwaukee



FAFNIR
BALL BEARINGS

THE MOST COMPLETE LINE OF BALL BEARINGS IN AMERICA

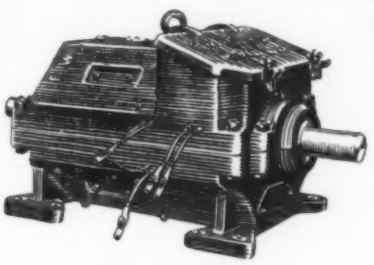


If your PRODUCTION demands a Crane

THAT crane is important. Stop it ... and you have a traffic jam.

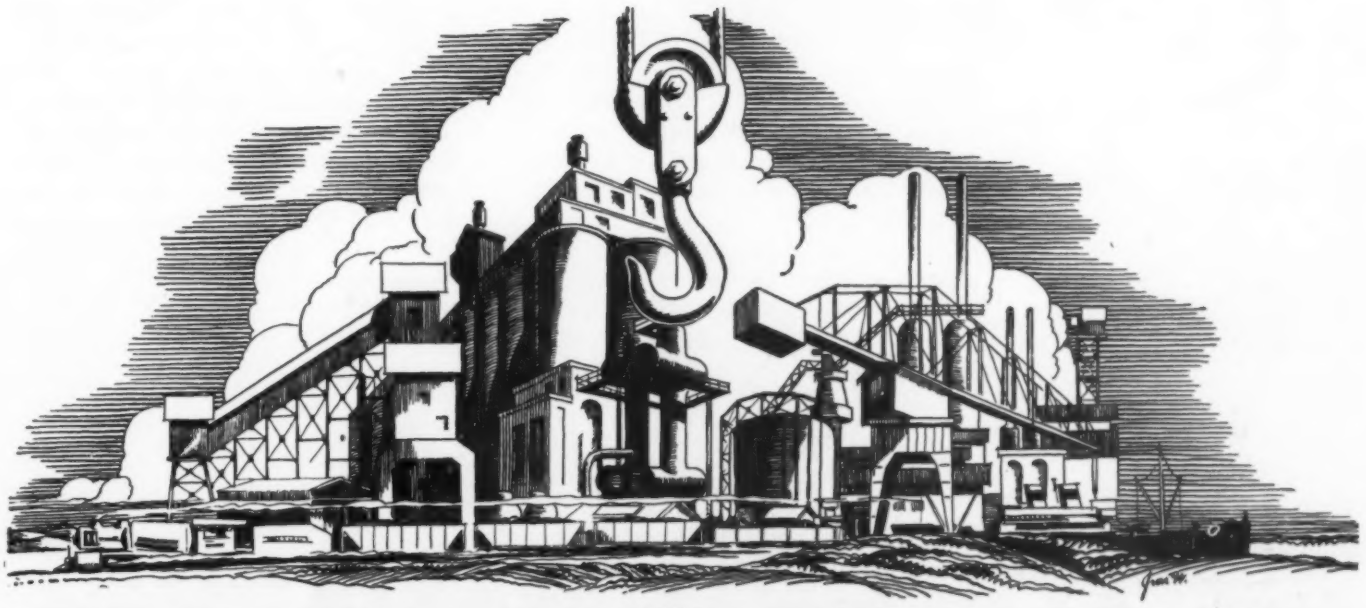
Cranes look complicated but they are really very simple and seldom cause trouble if given ordinary care. Most working parts are exposed and open to periodic inspection. But within the motor, you must take for granted the construction sealed inside the housing. Your only safeguard is the name plate.

If it reads Crocker-Wheeler, you know that the conditions under which the crane was planned to operate were studied before the motor was sold. You know the motor was not cheapened to meet price competition. You can rest assured that everything humanly possible was done to produce a motor installation that would not fail. Your Crane is too important a part of your plant to take casually. Look for the name plate on the motor.

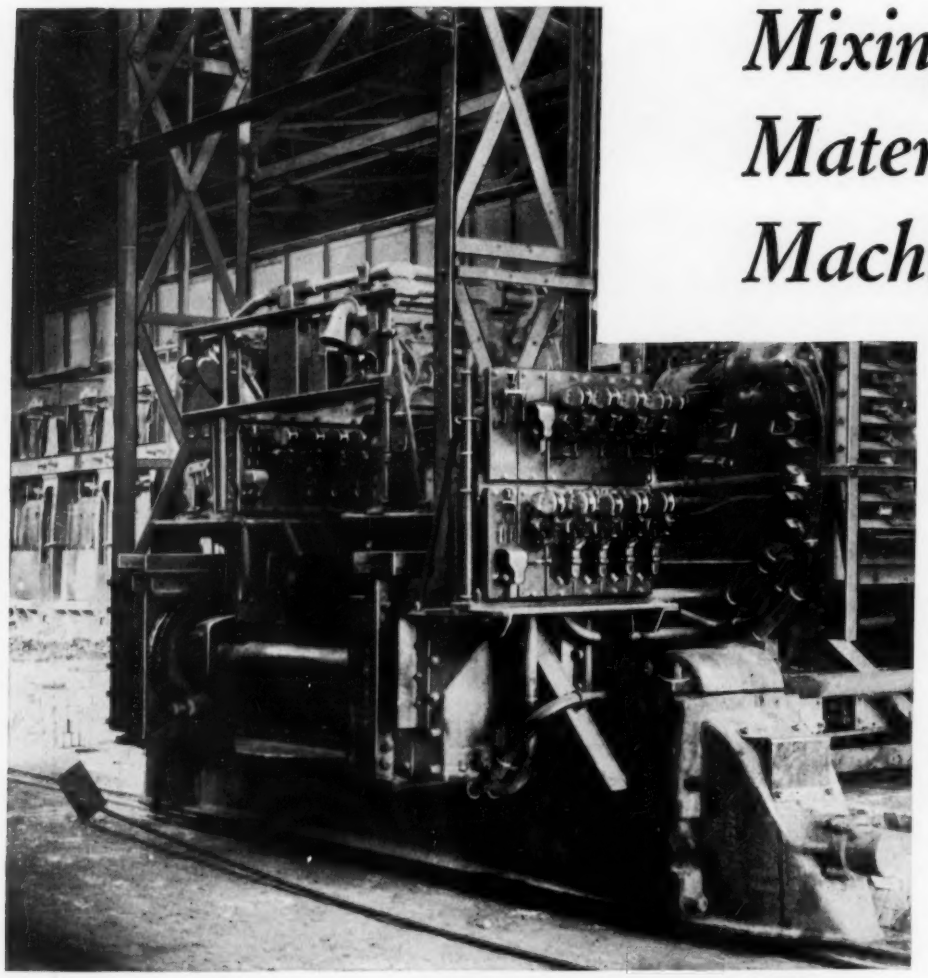


Birmingham
Boston
Buffalo
Chicago
Cincinnati
Cleveland
Houston
New York
Philadelphia
Pittsburgh
San Francisco
Seattle

CROCKER-WHEELER ELECTRIC MFG. CO.
Ampere, N. J.



CROCKER WHEELER



Mixing Men, Materials and Machines in Steel Mill Production

A floor type open hearth charger in a large eastern steel mill, equipped entirely with C-H ITL Control.

EVERY steel mill executive is faced with a task of harmonizing the factors of labor, machines and materials to get production flowing smoothly, profitably out of his plant.

Chief among these factors is the human element. You cannot push the speed of a machine past the point where the operator can control it . . . and become expert in its control. For only skilled operation brings top production. And only *duplicated* operation . . . repeated until it becomes a habit . . . brings the necessary skill.

That is why motor acceleration must always be smooth, uniform . . . why C-H *ITL* Control is used in mills where machines are driven for the last possible ton of production. For C-H *ITL* Control always brings the load to top speed in uniform time . . . the shortest safe time. There is no disconcerting delay on heavy loads . . . no abrupt acceleration on light loads. But there is full protection on overloads.

Furthermore, C-H *ITL* Control eases the load into action, preserving equipment from unnecessary strains. Its design is simple . . . without dashpots, relays, moving parts on the accelerating circuit. Its construction is rugged. There is a minimum of trouble, repairs or expense on C-H *ITL* Control . . . as shown by *five years' performance* in every type of mill application. Send for the booklet "Steel Must Never Stop," describing its performance in many well-known mills, the reasons for its superiority.

CUTLER-HAMMER, Inc.

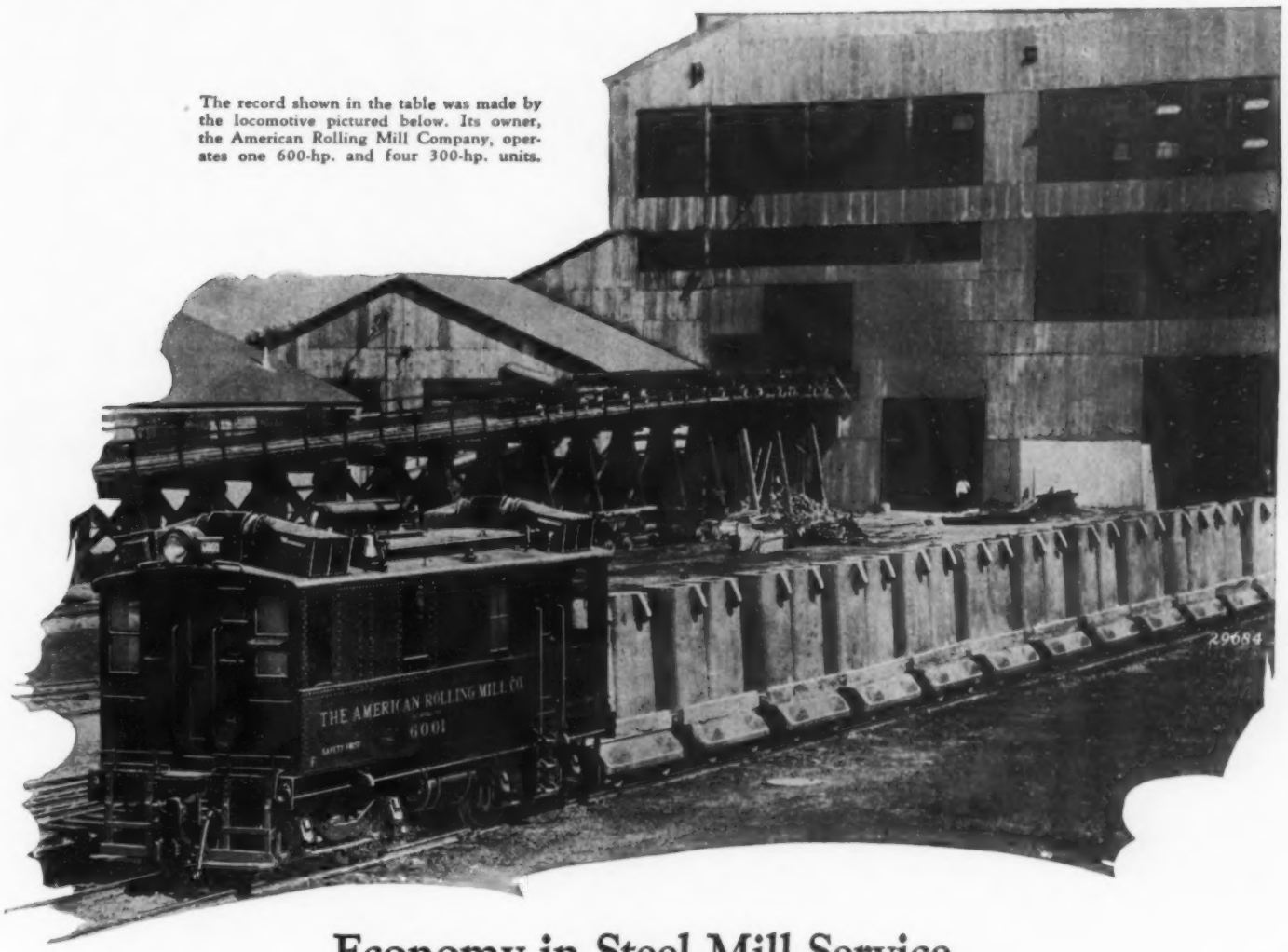
Pioneer Manufacturers of Electric Control Apparatus

1269 St. Paul Avenue MILWAUKEE, WISCONSIN

CUTLER HAMMER

The Control Equipment Good Electric Motors Deserve

(8635)



The record shown in the table was made by the locomotive pictured below. Its owner, the American Rolling Mill Company, operates one 600-hp. and four 300-hp. units.

Economy in Steel Mill Service

A splendid record of economical operation—but it is not unusual for the oil-electric:—

COST OF OPERATION PER LOCOMOTIVE HOUR

Year 1928	Oil-Electric, 12 Months	Steam, 12 Months
Labor	$1.660	$3.310
Fuel	.365	1.210
Supplies	.080	.020
Repairs (Material and Labor)	.560	1.070
Engine House	.205	.795
Depreciation	.815	.115
Superintendence	.895	1.065
Interest	.505	.115
	$5.085	$7.700

Average Saving per Hour, Oil-Electric—$2.615

Steel mill service is a severe test for any locomotive. Actual figures prove the oil-electric to be the most efficient and economical unit for both railroad and industrial work.

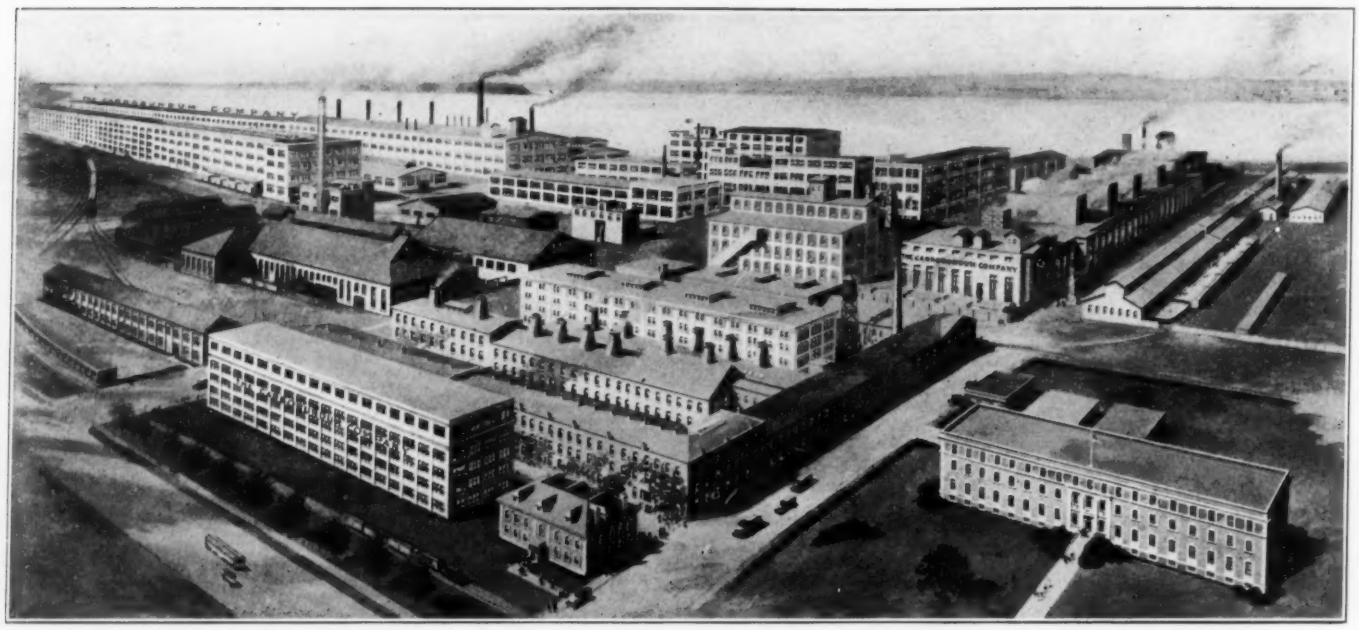
INGERSOLL-RAND COMPANY - 11 BROADWAY - NEW YORK CITY

Branches or distributors in principal cities the world over

For Canada Refer—Canadian Ingersoll-Rand Co., Limited, 10 Phillips Square, Montreal, Quebec

11-OEL

Ingersoll-Rand



The Carborundum Company, Niagara Falls, N. Y., Manufacturers of Abrasive and Refractory Products.

An Outstanding Plant Chooses an Outstanding Fuse

The painstaking methods of The Carborundum Company demand only the best in equipment, machinery, materials and man power. Electrical protection, too, must withstand their strict requirements. And so TRICO Renewable Fuses were installed throughout their plant.

What a relief it must be to electrical engineers to know that fuses do not blow unnecessarily. That feeling of security is experienced wherever TRICO Renewable Fuses are used. The "powder-packed" feature, and other important points, save time and money.

Any they cost no more than other makes of renewable fuses

Free Samples on Request

Approved by Underwriters' Laboratories

TRICO
Renewable
FUSES
They're "Powder-Packed"

Money-Saving TRICO Factors

No Premature Blowings
No Unnecessary Shutdowns
No Oxidized Contacts
No Charred Castings
Copper-to-Copper Contacts
Reduced Watt Loss
Time Lag

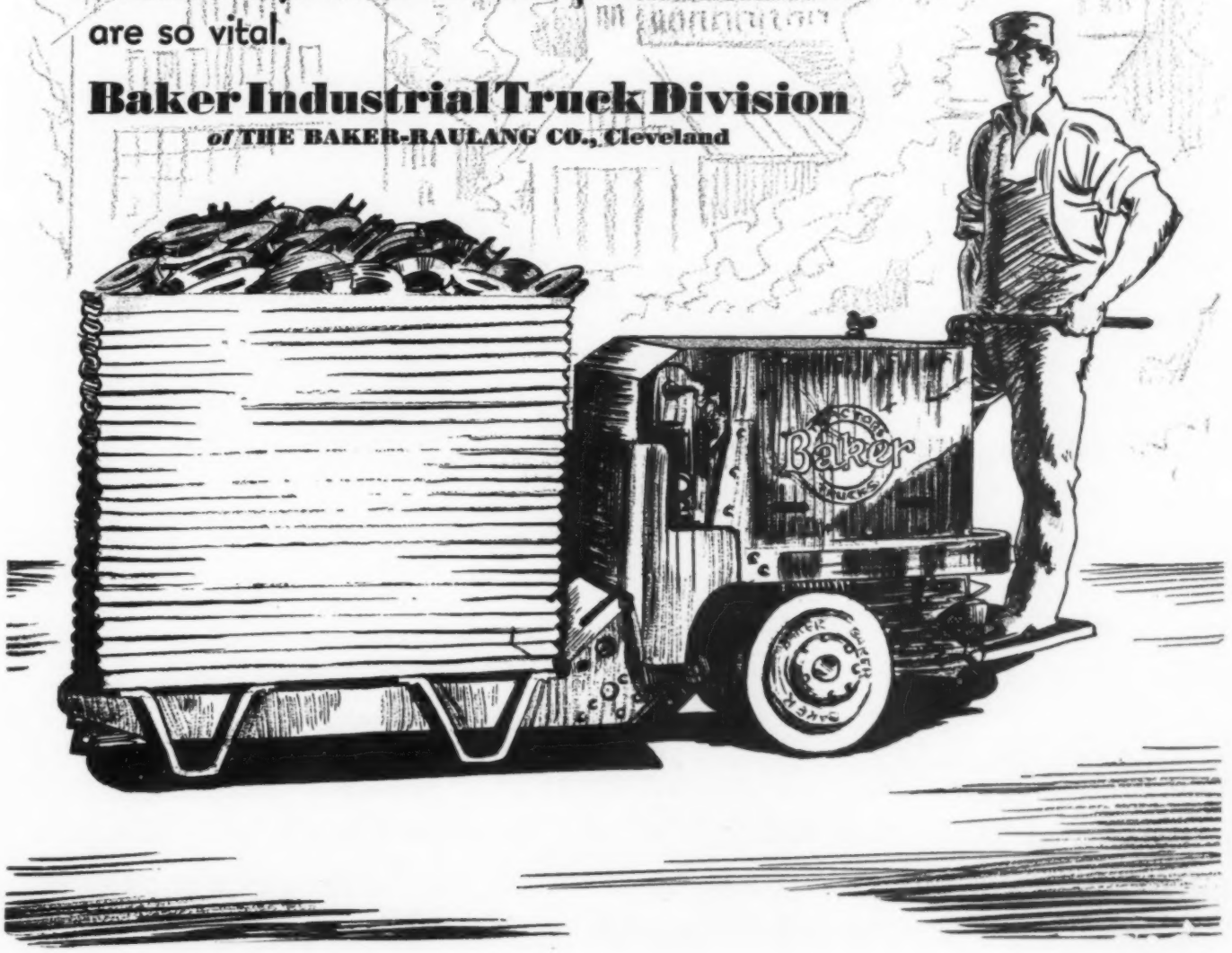
TRICO FUSE MFG. CO., 1006 McKinley Ave., Milwaukee, Wis.

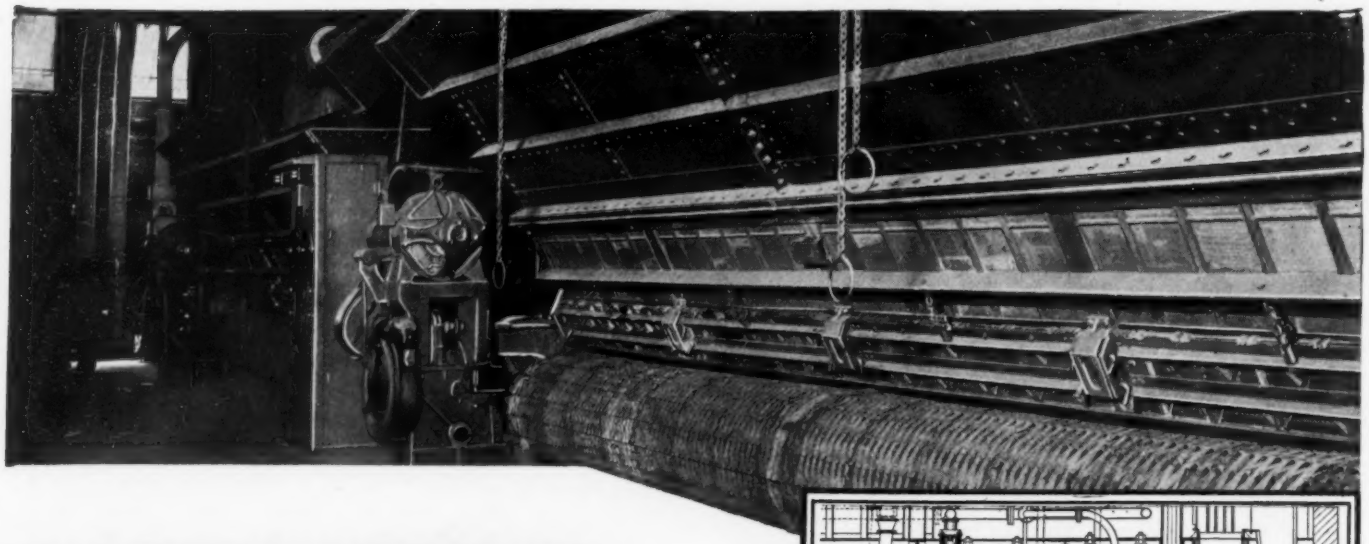
GIVE it enough work and the entire cost of a Baker Truck will be written off in two to four months by actual reductions in your pay roll.

The other savings the Baker will make are pure velvet—saving in floor space, reduction of idle machine hours, speeding up production, reducing accidents and greatly reducing your labor turnover.

These extra savings alone are worth the cost of the Baker, yet you get them for nothing. Your question isn't: can you afford a Baker, but can you afford to be without one, in these days when reduced production costs are so vital.

Baker Industrial Truck Division
of THE BAKER-RAULANG CO., Cleveland



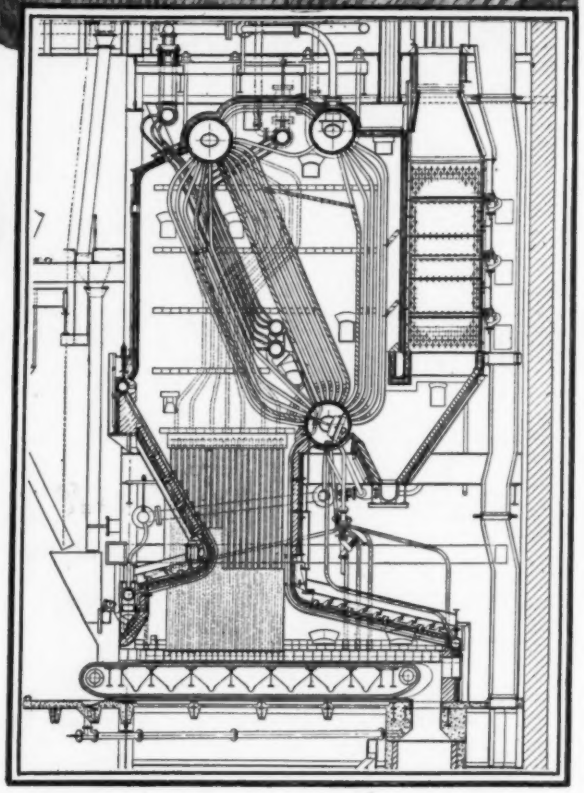


DISTINCTIVE INSTALLATIONS of C-E Equipment

The Grand Avenue Station of the Kansas City Power and Light Company is representative of the modern trend in steam generating equipment toward larger units and higher pressures.

The stokers — the largest machines of their type in the world — the boilers, designed for 700 lb. maximum working pressure, the water-cooled furnace walls, the economizers and the air preheaters were all designed, fabricated and installed by Combustion Engineering Corporation.

Three co-ordinated units were installed in the space previously occupied by sixteen small boilers and have a capacity of approximately 275,000 lb. of steam more than the sixteen old units — with space for another unit still available.



Cross section through setting at Grand Avenue Station, showing C-E Stokers (Green Forced Draft Type) 22 ft. long by 24 ft. wide, C-E Boiler (Ladd Type) 700 lb. maximum working pressure, C-E side wall furnace screens, C-E fin tube economizers, C-E air preheater and water-cooled front and rear stoker arches.

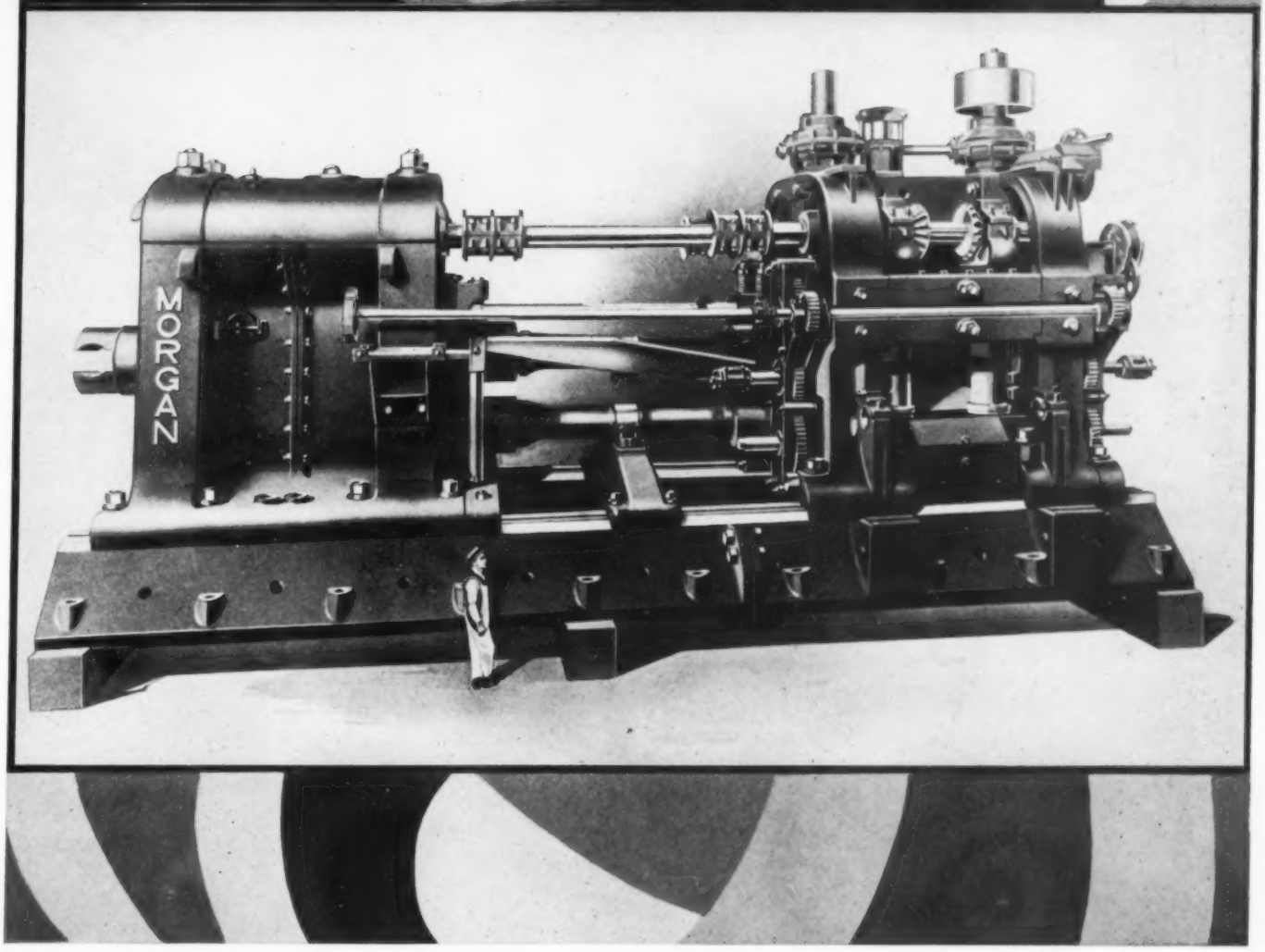
May we send you our General Condensed Catalog describing C-E Equipment?

COMBUSTION ENGINEERING CORPORATION

International Combustion Building . 200 Madison Avenue, New York, N. Y.

A SUBSIDIARY OF INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

MORGAN 60 INCH UNIVERSAL MILL



BUILT BY PIONEER MILL BUILDERS

Morgan has built two 60-Inch Universal Plate Mills, the largest of their kind in the Country.

They have recently built and have in successful operation a 54-Inch Blooming Mill, one of the largest in the world.

Morgan builds PLATE MILLS—BLOOMING MILLS—STRUCTURAL MILLS—ROD MILLS—BAR MILLS—CONTINUOUS MILLS—AND ROLLING MILL EQUIPMENT.

THE MORGAN ENGINEERING COMPANY

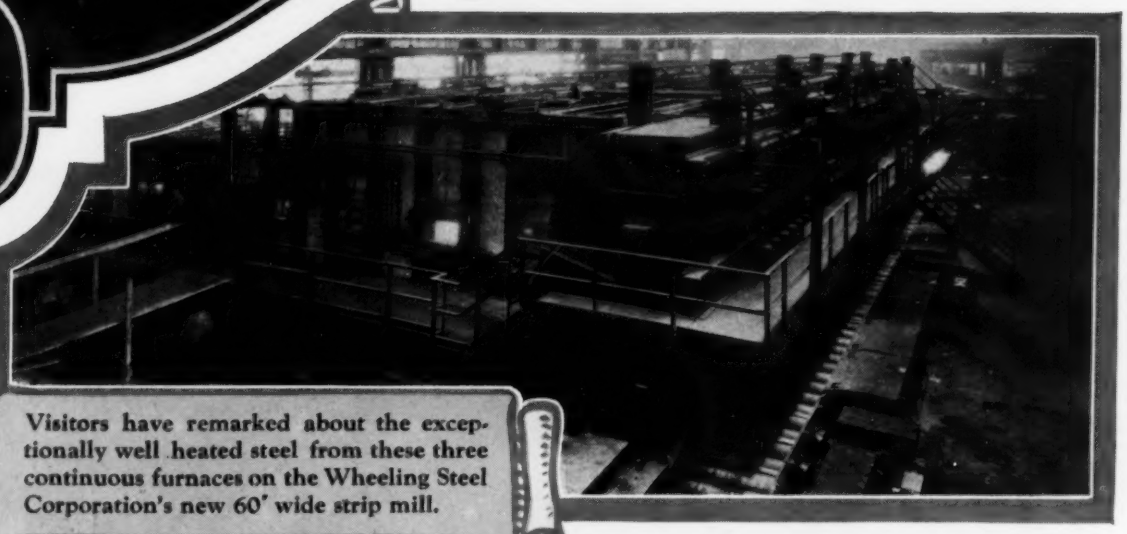
ALLIANCE, OHIO, U. S. A.

Electric Traveling Cranes, Rolling Mill Machinery, Steam Hammers, Steam Hydraulic Forging Presses

Hydraulic Presses, Rock Crushers, Machine Work of all kinds, Special Machinery for any purpose.

New York: 25 Broadway Pittsburgh: 1420 Oliver Bldg.

Designers, Manufacturers and Contractors



Visitors have remarked about the exceptionally well heated steel from these three continuous furnaces on the Wheeling Steel Corporation's new 60" wide strip mill.

Still another successful installation of three continuous slab heating furnaces is on the 48" wide strip mill at Weirton.

Another well satisfied customer is the Continental Steel Corporation, who is using this recently constructed continuous oil fired billet heating furnace.

THE CHAPMAN-STEIN CO.,
ALLIED WITH THE COOPER-

One of three continuous furnaces heating 10″ x 10″ and 12″ x 12″ blooms for a bar mill in the Pittsburgh district.

Nearly all the New Mills are Equipped with CHAPMAN-STEIN FURNACES

The new 48″ Mill at Weirton is equipped with three continuous producer gas fired Chapman-Stein Furnaces. The new 36″ Mill at the American Sheet & Tin Plate Company's Gary Plant is supplied with steel from three Chapman-Stein Continuous Furnaces. The new 60″ wide strip mill at the Steubenville Plant of the Wheeling Steel Corporation is operating with three large Chapman-Stein Continuous Slab Heating Furnaces. National Tube Company have contracted for six billet heating furnaces to be designed by Chapman-Stein for their new seamless mill at McKeesport, Pennsylvania. Each of these furnaces will be 70′ long. Great Lakes Steel Corporation have chosen Chapman-Stein Furnaces for both their new 20″ and 14″ Mills. The furnaces for the 20″ Mill will each be designed for forty-five tons per hour, and the furnace for the 14″ Mill will have fifty tons per hour capacity.

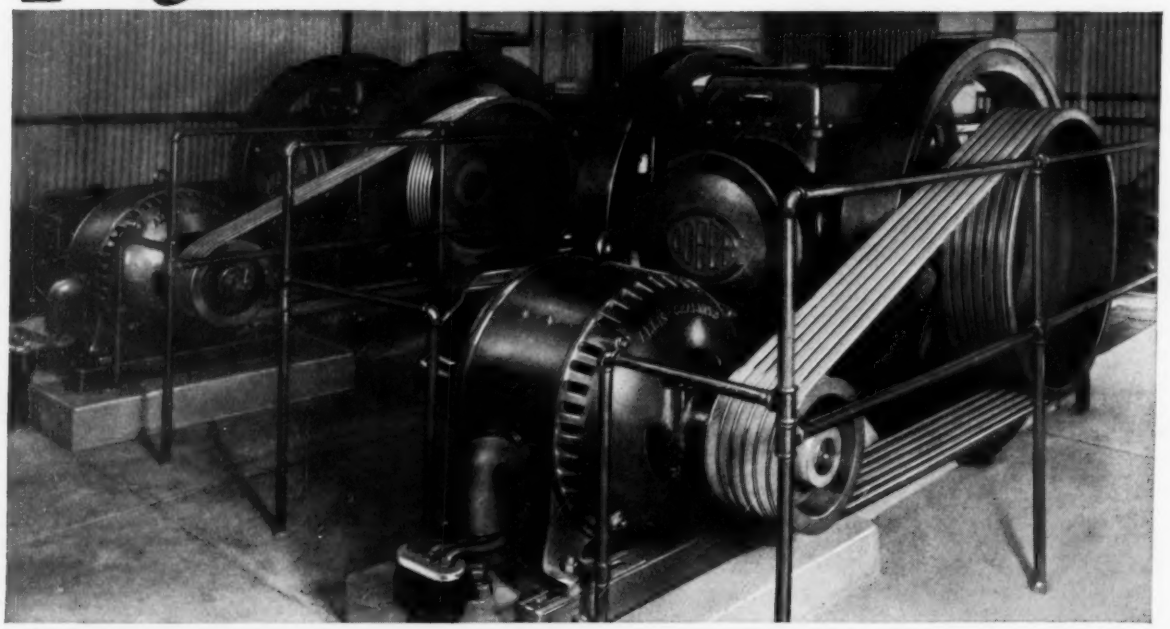
Other companies who have recently contracted for Chapman-Stein equipment are:

1. Continental Steel Corporation
2. John A. Roebling's Sons Company
3. The Corrigan, McKinney Steel Company
4. Pittsburgh Steel Products Company
5. Pittsburgh Crucible Steel Company
6. The Bourne-Fuller Company
7. The American Rolling Mill Company, Butler Plant
8. Laclede Steel Company
9. Algoma Steel Corporation
10. Weirton Steel Company (second repeat order)

The confidence shown by the above companies is highly valued and is responsible for the rapidly growing list of users of this equipment.

MOUNT VERNON, OHIO
BESSEMER CORPORATION

Everywhere TEXROPE is acclaimed the *"perfect Drive"*



ALLIS-CHALMERS has perfected a transmission that never fails . . . that performs without upkeep cost . . . that operates safely, silently and efficiently in minimum space.

Texrope Drive makes shutdowns due to transmission failure practically impossible. Should one or two of the Texrope belts wear out, the rest of the belts will transmit the power until it is convenient to make the replacement.

Texrope Drive operates with amazing efficiency even under the most severe conditions. Excessive moisture does not affect it. Shock loads make no difference in its performance. It absorbs vibration and runs with a smoothness almost unbelievable. Even after years of hard service, it is silent, clean and efficient.

In practically every industry Texrope Drive has proven its superiority. Many manufacturers of machines on which the drive is original equipment have standardized on Texrope. Everywhere it is recognized as the closest approach to power transmission perfection. Its test-proven efficiency is 98.9% . . . In your plant there are many opportunities to save money with Texrope Drives. Let us show you how other manufacturers are getting more perfect work at less cost with Texrope.

ALLIS-CHALMERS MANUFACTURING COMPANY—Texrope Division—*Milwaukee, Wisconsin*

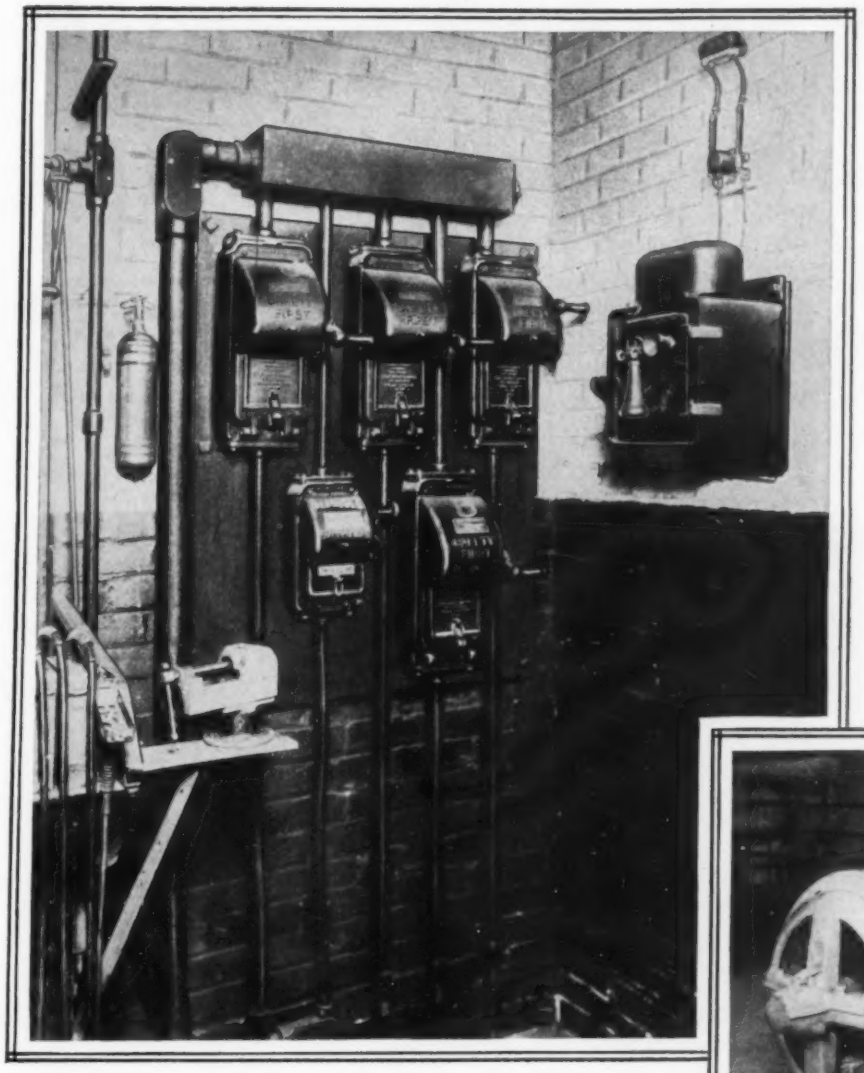
Write for Bulletin No. 1228-J

ALLIS-CHALMERS

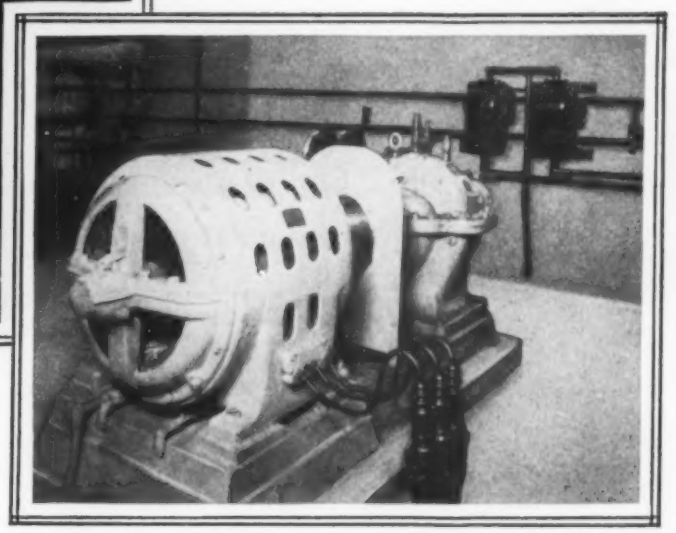
TEXROPE DRIVES

THE PERFECT TRANSMISSION — ALLIS CHALMERS TEXROPE DRIVE — FOR EVERY PURPOSE ··

SAFETY SWITCHES



Type MK Safety Switch



To secure continuity of service, all the live parts of devices for the control of electrical apparatus should be completely enclosed.

The MK series of Condulets consists of a line of fusible knife switches in Cast-feraloy housings, operated by an outside handle. The door over the fuse compartment gives access to the fuses, but as this door is interlocked with the handle, the fuses are accessible only when dead. Provision for locks has been made so that it is possible to lock the switch in the "off" or "running" position.

Detachable hub plates make possible various conduit hub arrangements.

CROUSE-HINDS

ESTABLISHED 1897

SYRACUSE, N. Y., U. S. A.

SALES OFFICES

NEW YORK PHILADELPHIA BOSTON DETROIT ATLANTA CHICAGO CLEVELAND MILWAUKEE ST. LOUIS CINCINNATI PITTSBURGH SAN FRANCISCO MINNEAPOLIS LOS ANGELES

C-H479

ONE Company has placed 9 *orders in* 12 *months for* 19 *installations totaling* 715,000

CFM —evidence of satisfactory service.

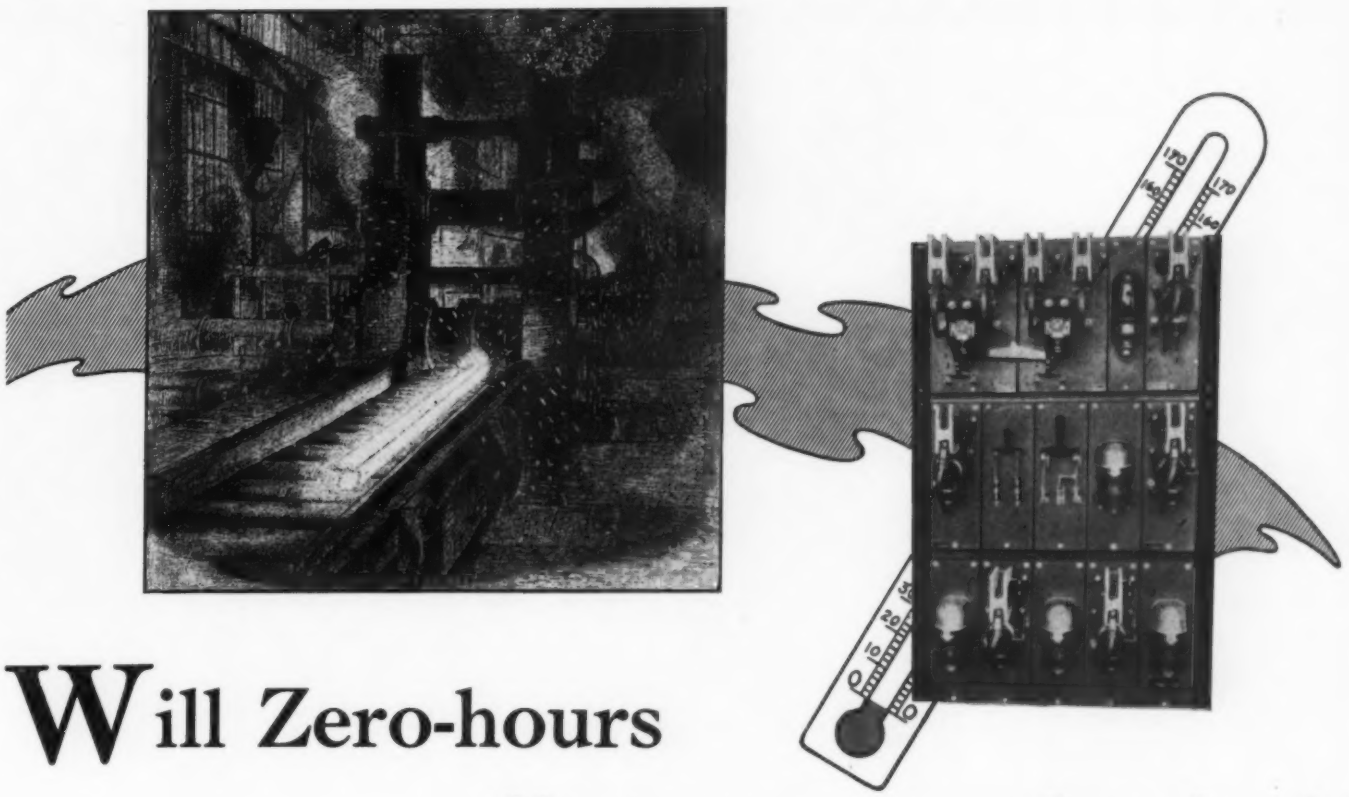
"Clever salesmanship may *sell* the first order but repeat orders are *bought* on performance."

The phenominal success of the Multi-Panel Air Filter is due to high efficiency in dust removal, positive self cleaning and dependable continuous operation.

REED AIR FILTER CO.
Incorporated
230 Central Avenue
LOUISVILLE, KY.

The filter curtain is composed of overlapping woven-screen panels which are automatically separated and individually cleaned upon entering the oil reservoir at the base of the filter. Thus combining high efficiency with positive self-cleaning. For complete engineering data ask for Bulletin No. 117.

The **Multi-Panel Air Filter**



Will Zero-hours affect your production?

"WILL steel go forward without delay?" . . . that is a problem no superintendent should have to worry about. He should know that his mills will always be ready for the steel as it comes down from the pits . . . no interruptions, when cold gear grease on Monday mornings causes abnormal loads on motors and machinery . . . no delays after the mill has been limbered up. Then and only then can steel be moved forward in the fastest possible time.

EC&M Time-Current Control always adjusts itself to accelerate motors quickly, safely . . . and without delay. If the load is abnormal, longer time eliminates unnecessary interruption to power . . . but just as soon as the load is again normal, the controller responds automatically to the easier conditions and the mill is soon operating at full speed.

Even under stalled motor conditions, Time-Current Control will force motors to their maximum output . . . but in a safe manner. Because of the longer time given motors to accelerate, overload relays can be set at lower values, so they are a real protection to both motors and machinery.

It is not yet too late to order Time-Current Control for your mill drives. Do it now . . . yet remember, you not only have protection when needed on cold winter mornings, but also, the fastest possible production as soon as the mill limbers up . . . and all this without any change in adjustment.

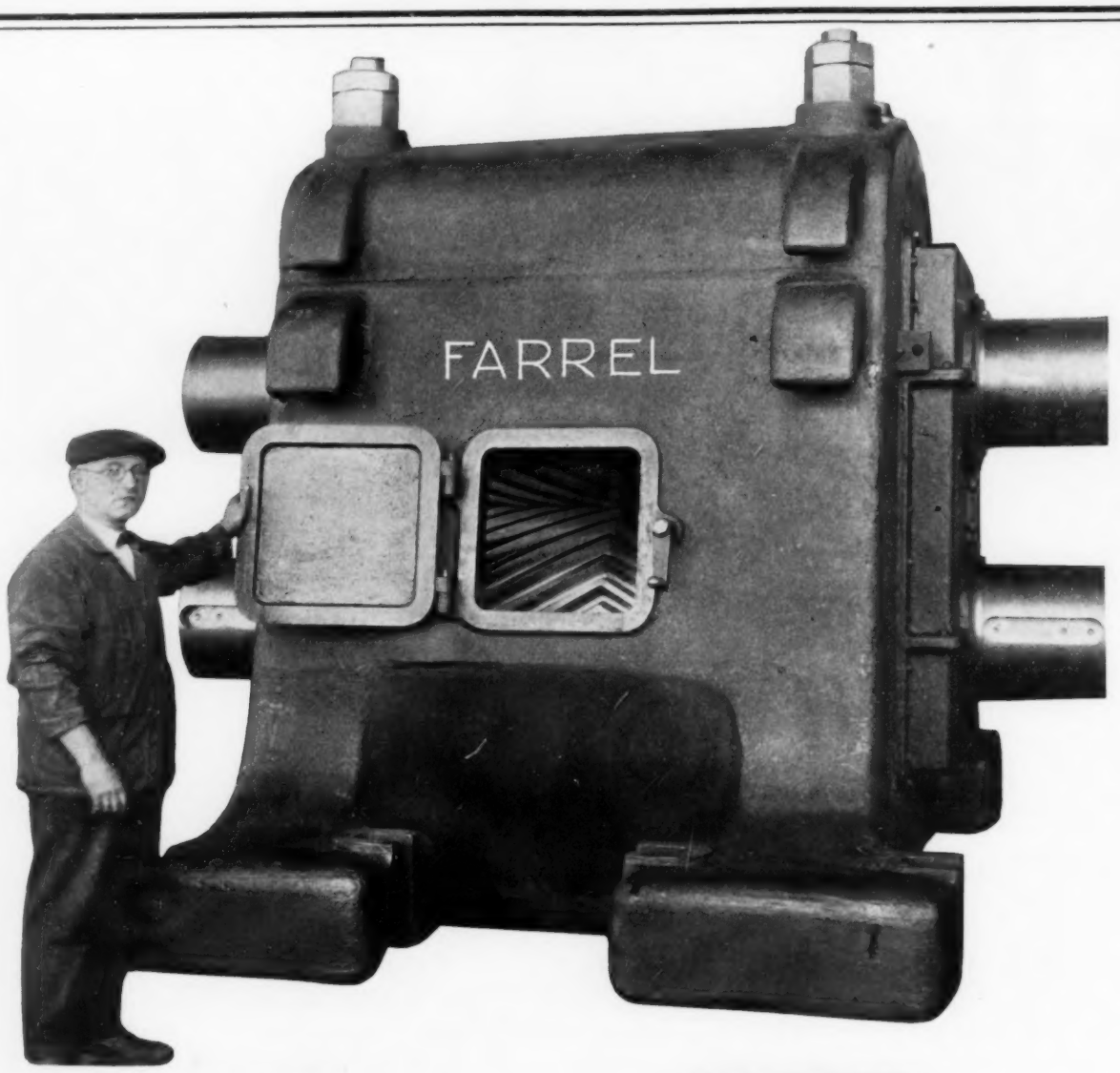
Be Protected with

TIME CURRENT CONTROL

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

NEW YORK-50 CHURCH ST.
CHICAGO-CONWAY BLDG.
DETROIT-DIME BANK BLDG.
BIRMINGHAM-BROWN-MARX BLDG.
CINCINNATI-PEARL NATIONAL BANK BLDG.
DENVER-KITTREDGE BLDG.
LOS ANGELES-912 E. THIRD ST.
HOUSTON-1006 WASHINGTON AVE.
TORONTO-REFORD BLDG.
PHILADELPHIA-WITHERSPOON BLDG.
PITTSBURGH-OLIVER BLDG.
SAN FRANCISCO-CALL BUILDING
MONTREAL-CASTLE BLDG.
TULSA-217 E. ARCHER ST.
SEATTLE-ALASKA BLDG.

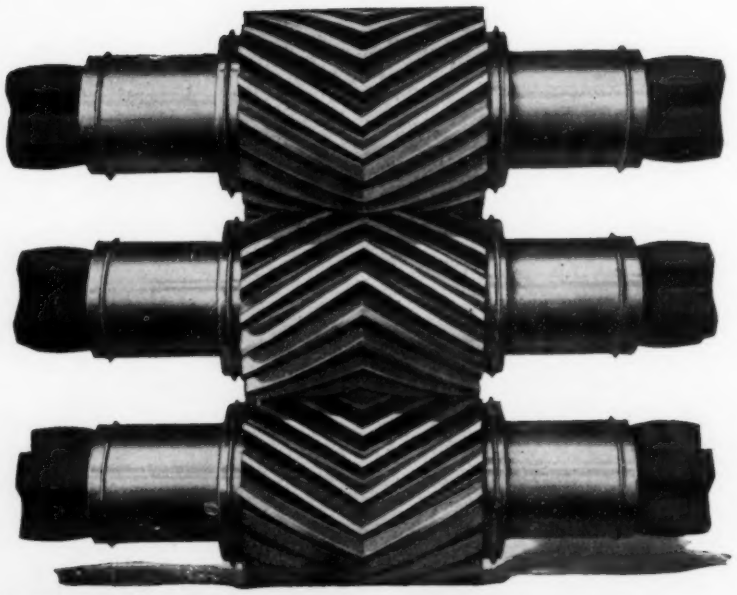


FARREL-SYKES

MILL PINIONS AND PINION STAND

Great strength and long life free from noise and vibration is obtained with Farrel-Sykes continuous tooth herringbone mill pinions.

And when the stand is made by Farrel the pinions are properly mounted, lubricated and capable of withstanding the greatest shocks encountered.

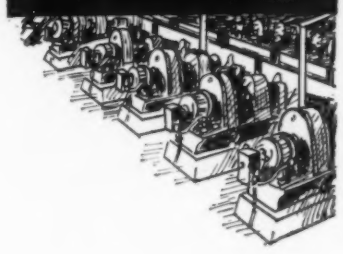


FARREL-BIRMINGHAM CO. Inc.

SUCCESSOR TO
FARREL FOUNDRY & MACHINE CO., ANSONIA, CONN., AND
BUFFALO, N. Y., AND BIRMINGHAM IRON FOUNDRY OF DERBY, CONN.
ADDRESS REPLIES TO THIS ADVERTISEMENT TO BUFFALO PLANT
344 VULCAN ST., BUFFALO, N. Y.

COSTLY MAINTENANCE HAS BEEN AND CAN BE MINIMIZED

Why not in your mill?



Are your purchases based on initial cost or on cost plus the life of the equipment? Mills are running full speed, motors humming day and night—every unit must function perfectly. Isn't that sufficient reason for installing dependable Bus Supports and Switches in your plant?

The Franklin Type "T" equipment, shown below, is both puncture-proof and vibration-proof. A sure bond between hardware and porcelain — obtained through the die-metal construction is your assurance for perfect performance under the most severe conditions. Install equipment which will last a little longer and your "investment" is justified.

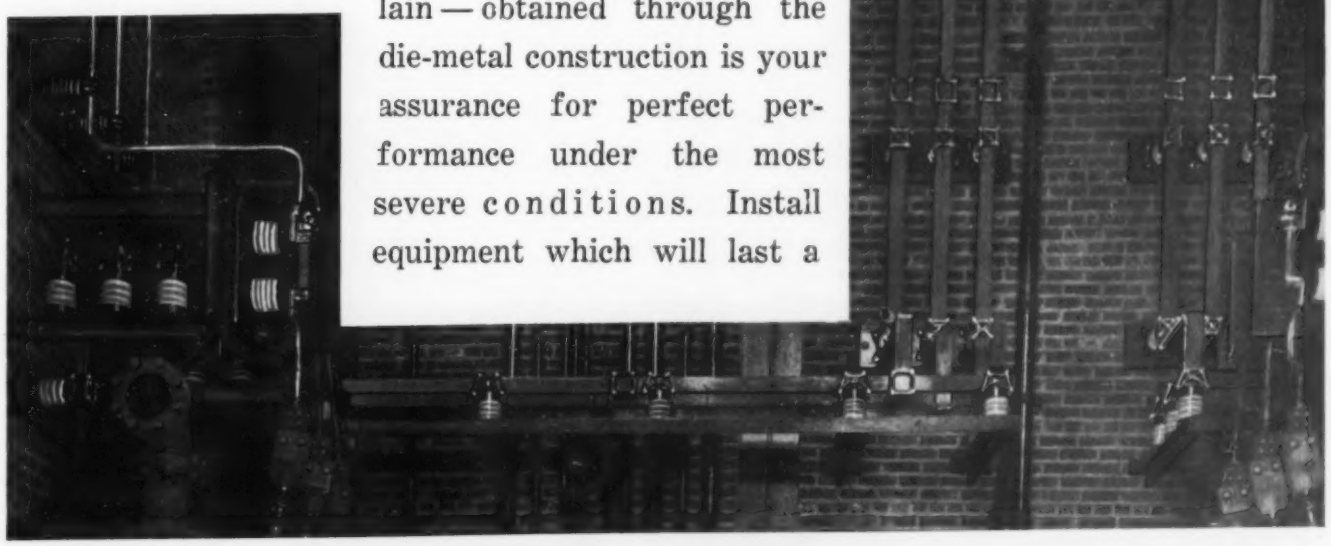
Install Franklin equipment of proven merit and your maintenance costs are minimized.

RAILWAY AND INDUSTRIAL

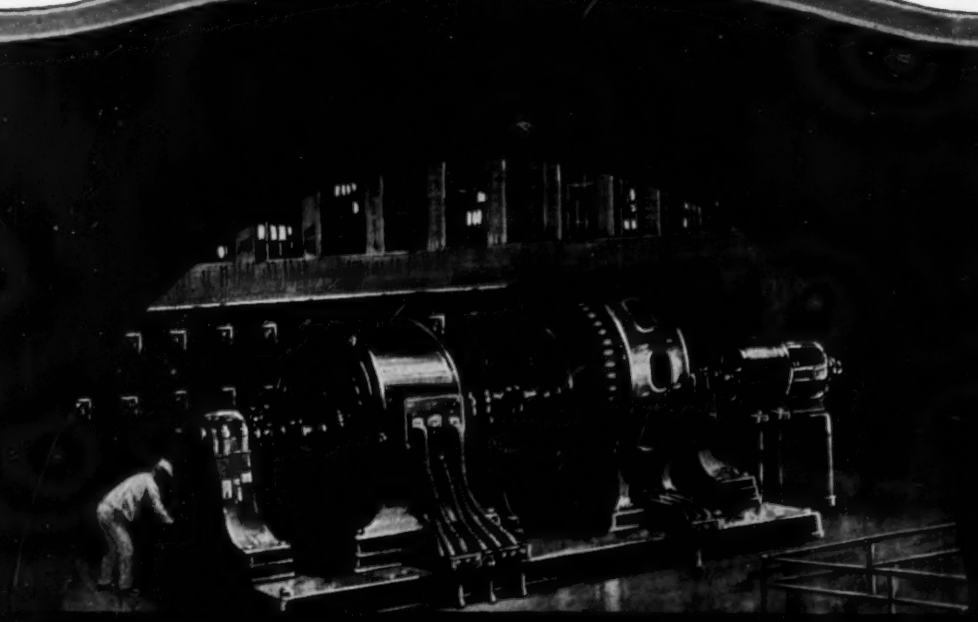
Engineering Co., Greensburg, Pa.

OFFICES IN

Boston	Pittsburgh	St. Louis
New York	Charlotte	Chicago
Philadelphia	Cincinnati	Denver
	Cleveland	



FRANKLIN INDOOR EQUIPMENT



ECONOMY *renewable* FUSES

INDUSTRIES using electrical energy save 80% annually in fuse maintenance costs when they install Economy renewable Fuses in the place of "one-time" fuse-equipment.

Economy Fuse performance is a matter of record—they were the first fuses using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be *Approved in All Capacities* by the Underwriters' Laboratories.

Economy "Drop-Out" Renewal Links cost but little and make the restoration of a blown fuse the work of a moment only.

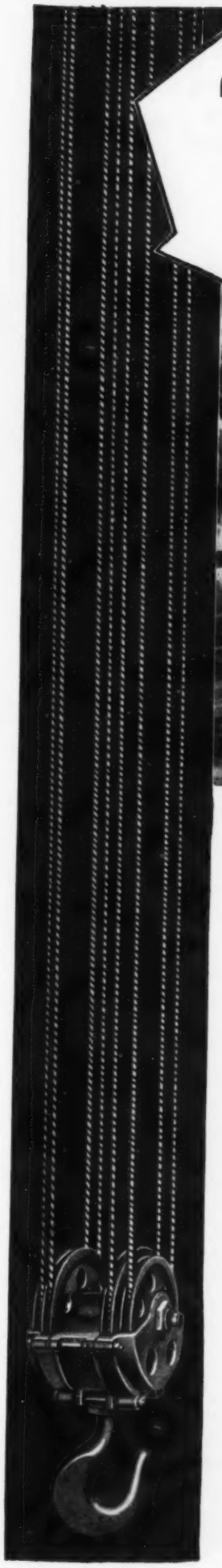
Your plant needs Economy Fuses. Investigate the quality of the electrical protection you now have from the standpoint of dependability, efficiency and economy.

Then order Economy Fuses installed.

For Sale by all leading Electrical Jobbers and Dealers.

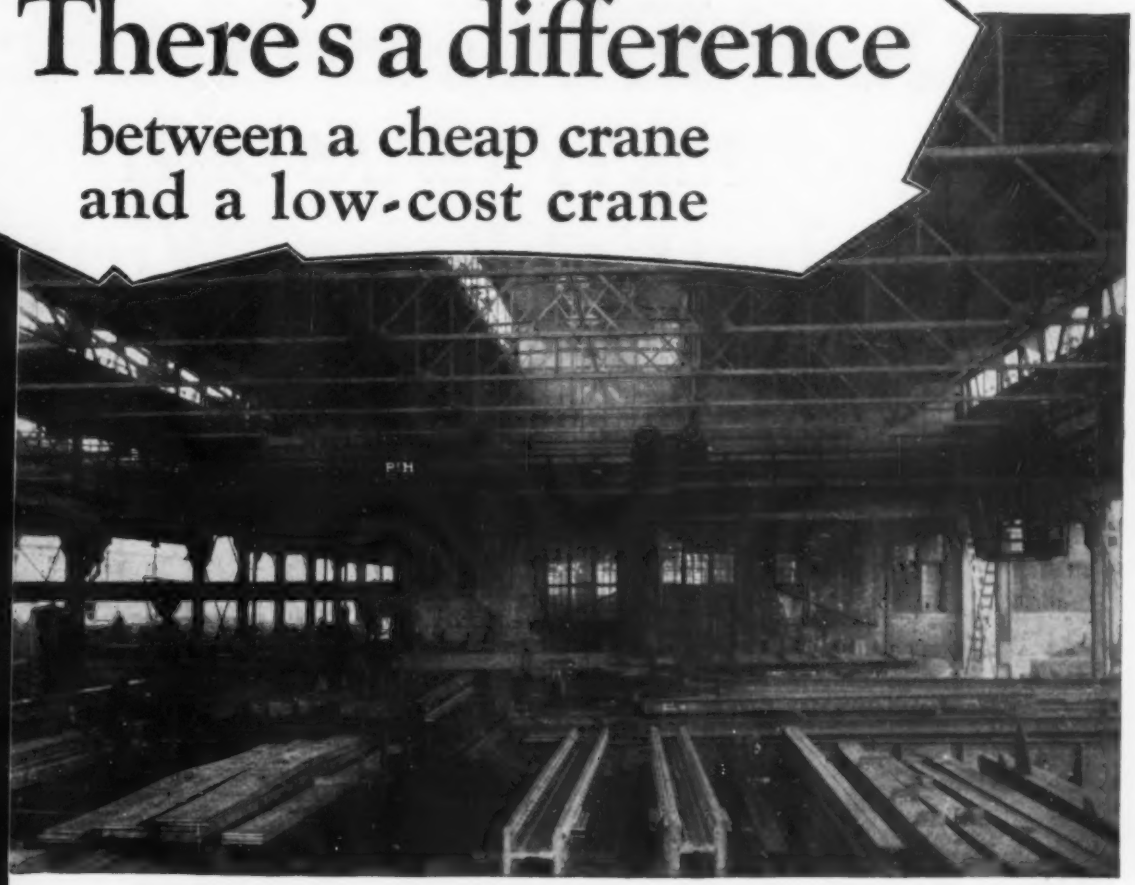
ECONOMY FUSE & MFG. CO., Chicago, U. S. A.

Economy Fuses are also made in Canada at Montreal



There's a difference

between a cheap crane and a low-cost crane



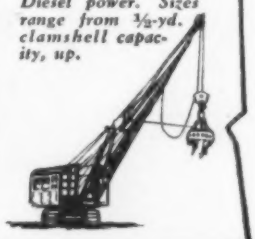
THE real cost of a crane is not only the price you pay when you buy it but it includes cost of operation and maintenance over a period of years.

You can buy other cranes for less money than a P&H but you are not saving money unless these cranes operate as economically and with as few shut-downs as the P&H.

A cheap crane is cheap for the reason that it hasn't the same excellent workmanship and materials that a P&H has and can't possibly operate as economically and dependably.

Crane service must be dependable. A low-priced crane is apt to be shut down just when it is needed most, thereby causing a production loss many times greater than the original saving in first cost.

The P & H Corduroy (Crawler) Crane provides a material handling unit that goes anywhere over any kind of ground and handles every kind of loose material or stores. Gasoline or Diesel power. Sizes range from ⅜-yd. clamshell capacity, up.



If the price of a P&H Crane were multiplied by two, it would in many cases be a better buy.

Most industrial plants realize this and for this reason there are more P&H Electric Traveling Cranes in service than any other make.

HARNISCHFEGER CORPORATION
Established in 1884
Crane and Hoist Division
3855 National Avenue
Milwaukee, Wisconsin
Offices and Agents in All Principal Cities

P & H Cranes

9939

EXPERIENCE—

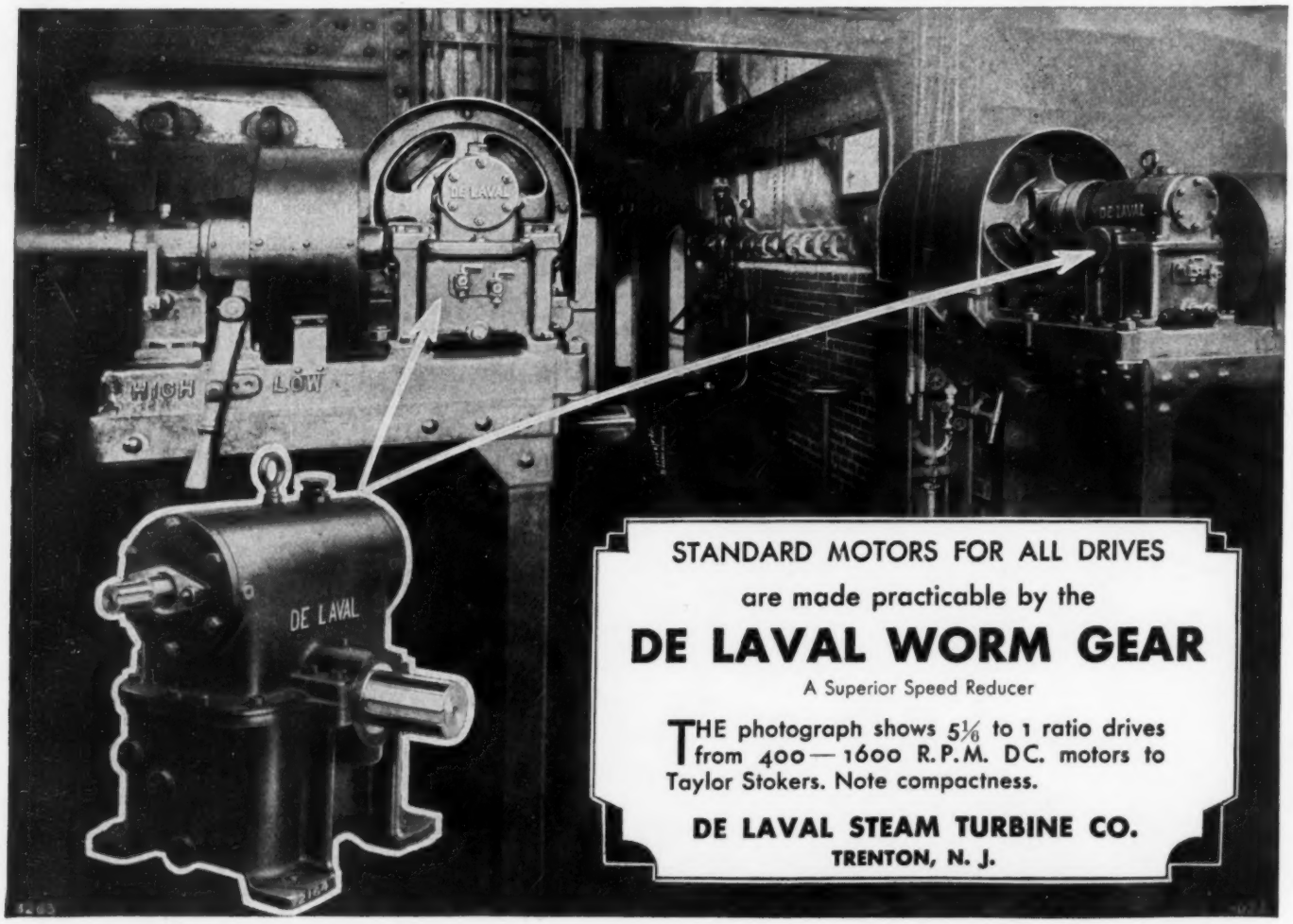
THIRTY YEARS OF IT

Industrial Power Wiring

Electric Furnace Installations
Pole Lines (High and Low Tension)
Sub Stations (High and Low Tension)
Heavy Crane Wiring
Pump and Motor Installations

Franklin Electric & Construction Co.

117 First Avenue Phone Court { 0922 0923 PITTSBURGH, PA.



STANDARD MOTORS FOR ALL DRIVES
are made practicable by the

DE LAVAL WORM GEAR

A Superior Speed Reducer

THE photograph shows 5⅛ to 1 ratio drives from 400—1600 R.P.M. DC. motors to Taylor Stokers. Note compactness.

DE LAVAL STEAM TURBINE CO.
TRENTON, N. J.

LARGEST BUILDERS OF THE WORLD'S LARGEST CRANES

Alliance Products

STANDARD CRANES
Up to 430 tons capacity

STRIPPING CRANES
Up to 320 tons capacity

COMBINATION CHARGERS and STRIPPERS
Up to 200 tons capacity

- Ladle Cranes
- Ingot Strippers
- Soaking Pit Cranes
- Open Hearth Charging Machines
- Slab and Billet Charging and Drawing Machines
- Gantry Cranes
- Ore and Coal Bridges
- Car Dumpers
- Forging Manipulators
- Steam Drop Forge Hammers
- Coke Pushers, Levelers and Door Lifters
- Coal Pier Equipment
- Rolling Mill Machinery
- Cement Plant Machinery
- Dock Handling Equipment
- Coke Oven Equipment

248 of 100 Tons Capacity and over

LADLE AND STANDARD CRANES

58		100 tons
2	WORM DRIVEN Ladle,	100 tons
2		115 tons
5	WORM DRIVEN Ladle,	125 tons
44		125 tons
27		150 tons
2	WORM DRIVEN Ladle,	150 tons
3	WORM DRIVEN Ladle,	160 tons
2	WORM DRIVEN Ladle,	165 tons
3	WORM DRIVEN Ladle,	175 tons
27		175 tons
3	WORM DRIVEN Ladle,	200 tons
2		200 tons
1		225 tons
1		250 tons
3	WORM DRIVEN Ladle,	250 tons
1		275 tons
3		430 tons

STRIPPING CRANES

8		100 tons
1		125 tons
21		150 tons
17		200 tons
1	Single Ram,	320 tons

COMBINATION CHARGERS AND STRIPPERS

3		100 tons
1		125 tons
3		150 tons
4		200 tons

Give Us the Runway and We will Lift the World

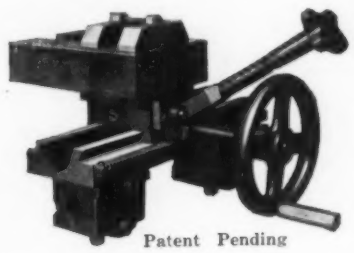
THE ALLIANCE MACHINE CO.
ALLIANCE, OHIO, U.S.A.
ENGINEERS AND BUILDERS

99.999% Accuracy!

Turning badly scored Commutators on a lathe is no longer necessary. Save time and lengthy shut-downs by using

IDEAL Commutator Precision Grinders

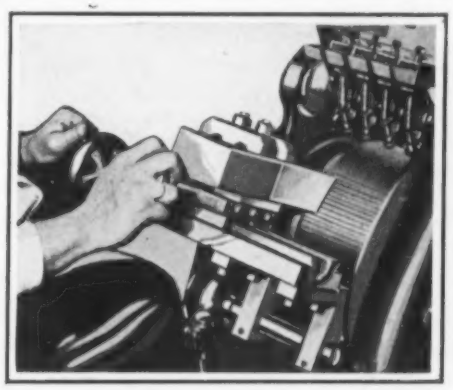
Accuracy to 1/1000 of an inch is common practice with Ideal Precision Grinders because **Commutators are turned in their own bearings at own speed.**



Patent Pending

Ideal model Precision Grinder (illustrated at left) is used on all the newer types of Commutators that have outboard fans and other obstructions. Rapid cross feed motion. Equipment includes Universal brush arm supports.

Fifteen thousand engineers say "It pays to use Ideal Commutator Resurfacers" because only one part of the Ideal stone is used to remove 5-2/3 parts copper.



"Perfect" model Precision Grinder is used on open type machines; reversible for right or left hand mounting upon flat or round brush arms.

Let us send you an Ideal Commutator Precision Grinder and Resurfacer on 10 days' free trial. State diameter of commutator, face-width,—clearance between brushes.

Block Handle Type Used in Ideal Portable Precision Grinders. Sizes 1½" x1½" to 3"x3". 5" or more long.

"U" Handle Type. Sizes 4"x4" to 16"x10".

Saw Handle Type. Sizes 4"x4" to 16"x10".

Vertical Adj. Handle Type. Sizes 2"x1½" to 4"x3".

Straight Handle Type. Size range from 1"x1" to 4"x1".

Service and Stocks in Over a Hundred Cities

BRANCH OFFICES:

421 Fulton Bldg. Pittsburgh, Pa. — **Machinery Bldg. Chicago, Ill.**

18 Warren Street New York, N. Y.

Any Ideal Tool on Free Trial

Ideal Commutator Dresser Co.

1045 Park Avenue, Sycamore, Illinois

12-29

IRON CITY ELECTRIC CO.

Westinghouse Agent Jobbers
The House That Service Built

The House Built For Service

Cor. Sixth Ave. & Diamond St. (Near Forbes Street) Pittsburgh, Pa.

DISTRIBUTORS FOR THE FOLLOWING LINES

Westinghouse Safety Switches
" " " Lighting Equipment
" " " Panel Boards
" " " Motors and Controls
" " " Transformers and Meters
" " " Insulators and Line Materials
" " " Lightning Arresters
" " " Insulating Materials and Other Supplies
" " " Mazda Lamps
" " " Fans
Erie Malleable Kondu Boxes
Crouse Hinds Condulets
Black & Decker Portable Electric Tools
Rome Super Service Cords and Cables
Beaver Stocks and Dies
Hubbard Pierce Pole Line Specialties
Tork Clocks
Central Tube Conduit
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Steel City Products
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P. & S. Wiring Devices
Bryant Electric Co.
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Harvey Hubbell, Inc.
National Carbon Co. Eveready and Columbia Batteries
American Wire Mold
Buffalo Breezo Ventilating and Exhaust Fans

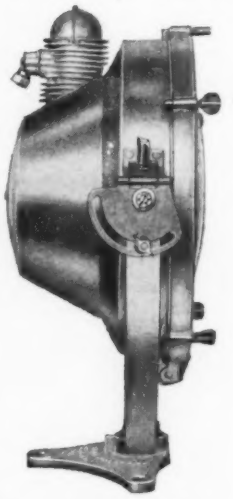
AND ALL KINDS OF ELECTRICAL SUPPLIES FOR INDUSTRIAL PLANTS, FACTORIES and MINES

An unusual night photograph of the railroad yard of a prominent eastern railroad floodlighted with Golden Glow projectors. Three towers are used, all similarly equipped with projectors. The one illustrated is equipped with seven 24-inch and ten 20-inch units.

FLOODLIGHTING
WITH
GOLDEN GLOW PROJECTORS

The new Golden Glow projectors of all aluminum construction which are fitted with the famous Golden Glow mirror glass reflectors and many other advantageous features of construction present a most efficient unit for railroad yard floodlighting and projects of similar nature about industrial plants. They are used extensively for building illumination because of their high efficiency and long lasting construction.

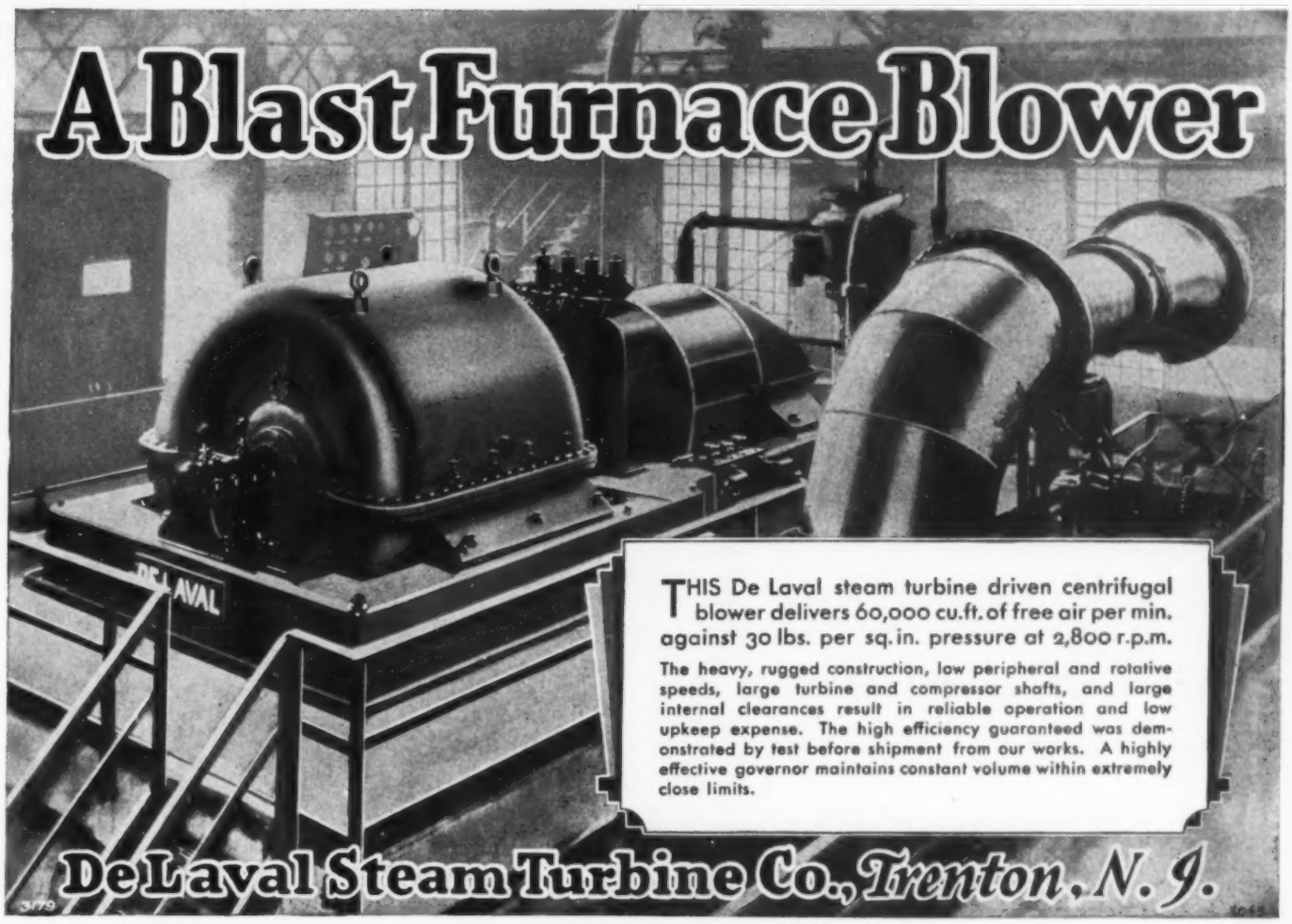
Our engineers are ready at all times to assist you with any illumination problems you may have. Call upon this service when you need it and send for catalog now.



ELECTRIC SERVICE SUPPLIES CO.
MANUFACTURER OF RAILWAY, POWER AND INDUSTRIAL ELECTRICAL MATERIAL

17th and Cambria Streets, Philadelphia, Pa.; 111 North Canal Street, Chicago, Ill.; 50 Church Street, New York.

Branches — Pittsburgh; Boston; Detroit; Scranton; Lyman Tube & Supply Company, Ltd., Montreal, Toronto, Vancouver.


A Blast Furnace Blower
DE LAVAL
THIS De Laval steam turbine driven centrifugal blower delivers 60,000 cu.ft. of free air per min. against 30 lbs. per sq. in. pressure at 2,800 r.p.m.
The heavy, rugged construction, low peripheral and rotative speeds, large turbine and compressor shafts, and large internal clearances result in reliable operation and low upkeep expense. The high efficiency guaranteed was demonstrated by test before shipment from our works. A highly effective governor maintains constant volume within extremely close limits.
De Laval Steam Turbine Co., Trenton, N. J.

Servicing *the*

HIGHLIGHTS

Made Easy and Safe With *of* **Industry**

THOMPSON LAMP SERVICING **HANGER**

No Climbing or Electrical Hazards

It is an overhead switch operated from the ground by rope or chain—cuts the lamp out of the electric circuit and brings it down to the man.

No dangling wires—and the chain may be in conduit if desired.

For both indoor and outdoor use—inexpensive and easily included in the present lighting system.

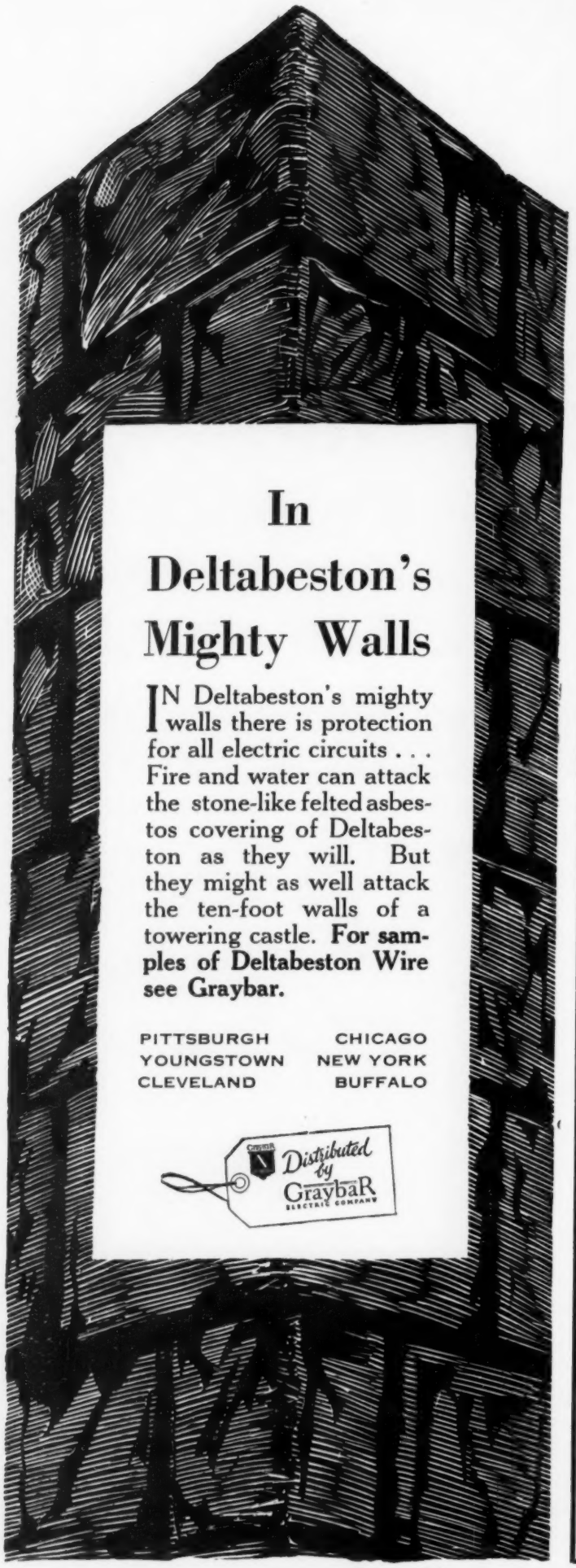
Encourages frequent cleaning, which tends toward maximum illumination at lowest cost.

Our new 32-page Catalog B-29 may help you to solve some lighting problems.

(Handled by Leading Electrical Jobbers)

The Thompson Electric Co.

1438 W. 9th St. **Cleveland, Ohio, U. S. A.**



In Deltabeston's Mighty Walls

IN Deltabeston's mighty walls there is protection for all electric circuits . . . Fire and water can attack the stone-like felted asbestos covering of Deltabeston as they will. But they might as well attack the ten-foot walls of a towering castle. **For samples of Deltabeston Wire see Graybar.**

PITTSBURGH CHICAGO
YOUNGSTOWN NEW YORK
CLEVELAND BUFFALO

Distributed by GraybaR ELECTRIC COMPANY

IN ADDITION TO

Marked Efficiency

WITH THE USE OF

"LE CARBONE"

CARBON BRUSHES

YOU WILL OBTAIN

Economies

THAT WILL SURPRISE YOU

✣✣

"They talk for themselves"—

✣✣

Le Carbone Co.

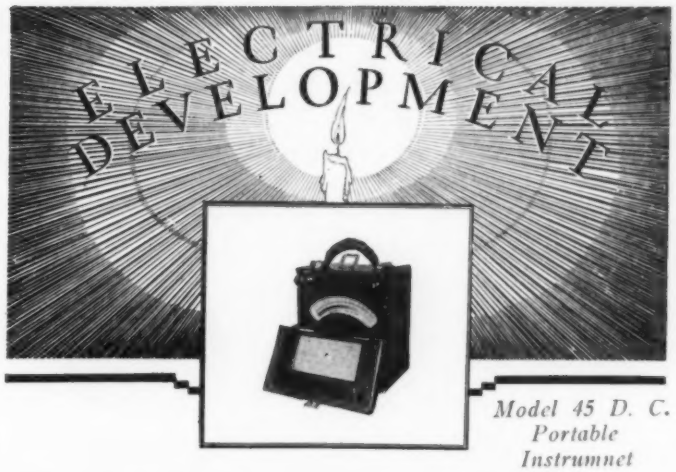
W. J. JEANDRON, Manager
Fifteenth and Bloomfield Streets,
HOBOKEN, N. J.

BRANCH OFFICES

Pittsburgh—634 Wabash Building A. M. Ramsey Sales Engineer
Chicago—1657 Monadnock Block E. C. Brehm, Sales Engineer
San Francisco—829 Rialto Building
W. R. Catching, Sales Engineer

CANADIAN DISTRIBUTORS

Lyman Tube & Supply Co.—Montreal and Toronto



Model 45 D. C. Portable Instrumnet

Can we throw some light on *your* problems?

NO single swallow makes a summer—nor does a single instrument go farther than a candle's feeble glow to lighten the problems of Electrical Development.

Take any Weston Instrument—any model or range. The most complete description possible would fail to convey a full conception of its probable uses. The needs of electrical measurement are too numerous and varied for even an attempt at classification with respect to the application of a single instrument or, for that matter, Weston's complete line of instruments.

It is a case where the mountain should come to Mohammed! For more than forty years the Electrical Industry has come to Weston for the solution of its measurement problems. With the tremendous increase in scientific developments, involving the use of new instruments and special requirements as to design, electrical characteristics and ranges, it is becoming a problem in itself to sense the exact needs in all branches of industry.

But Weston research, manufacturing and consultation facilities are available to all. Engineering and sales representation in all the principal cities of the world affords convenient points of contact with instrument headquarters, so that your problems *can be brought to us* for study and solution. If the abridged listing in our catalog does not cover the instruments you require, we shall be glad to receive your communication and will give it prompt attention.

Weston
PIONEERS SINCE 1888
INSTRUMENTS

WESTON ELECTRICAL INSTRUMENT CORP.
609 Frelinghuysen Avenue Newark, N. J.

Endurance

THE American or bald eagle, national emblem of the United States, is the king of birds. It soars above the clouds to heights of many thousands of feet. Besides having unusual strength, the eagle is noted for its wonderful endurance and has been known to exist without food for more than a month.

In steel mills and industrial plants, Westinghouse Duro Strain Insulators have established remarkable records of endurance. Their molded insulation body is unaffected by heat, moisture, snow, cold, or time.

When Duros go up, they stay for years and cost so little they make cheap insulators expensive.

WESTINGHOUSE ELECTRIC & MFG. CO.
EAST PITTSBURGH PENNSYLVANIA

SALES OFFICES AND SERVICE SHOPS IN ALL PRINCIPAL CITIES OF THE UNITED STATES

Westinghouse

T 30911

WHEELER DURATACH

—a new Reflector construction of greater efficiency, convenience and economy

Quickly put up—or taken down, Duratach offers a greater convenience in wiring than has ever been known before. A few quick turns—and reflector, socket shell and lamp are removed *as a single unit.* This feature avoids the handling of hot lamps and unnecessary handling of parts. It is not necessary to break the circuit when relamping Duratach Reflectors, either medium or mogul base, as circuit is broken in socket when reflector is removed from canopy.

1. DURATACH PORCELAIN SOCKET BASE is attached to canopy by two screws which fit into bayonet holes in the socket base. Accommodates all Medium and Mogul base Duratach Reflectors.

2. SOCKET SHELL is attached to Duratach socket base by contact prongs and is supported in reflector neck by a metal disc. This arrangement permits socket shell to revolve with reflector as it is screwed in or out of canopy.

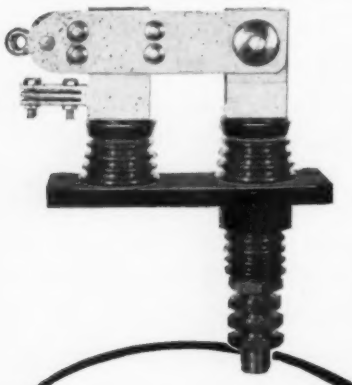
3. REFLECTOR AND SOCKET SHELL screw in and out of canopy quickly and easily **as one unit,** making both mechanical and electrical connections in one operation. This means that reflector, lamp and socket shell can be removed from canopy **as one piece.**

Detailed photo of Duratach construction

Write for Wheeler 1929 Catalogue for further information

DOUBLEDAY-HILL ELECTRIC COMPANY

110-112 Seventh Street **Pittsburgh, Pa.**



YOU CANNOT SUBSTITUTE FOR "THREE E" RELIABILITY

Get double blade benefits with less operating costs

Double Blade Switches "Three E" Feature meaning Cooler Operation Greater Durability and Better Contact

The "Three E" organization was the originator of Double Blade Switch Construction. "Three E" Double Blade Switches are being extensively used today because they have conclusively demonstrated their superiority. Here again is a reason for the **well known "Three E" *Service Value.**

We will be glad to give you further details on "Three E" Switches. Our Bulletin No. 112 shows the variety of Double Blade types we make.

"THREE E"
HIGH QUALITY
LINE AND STATION EQUIPMENT

*"Service Value" = Low cost per year of service

Electrical Engineers Equipment Co.

General Office and Factory: MELROSE PARK, ILL.

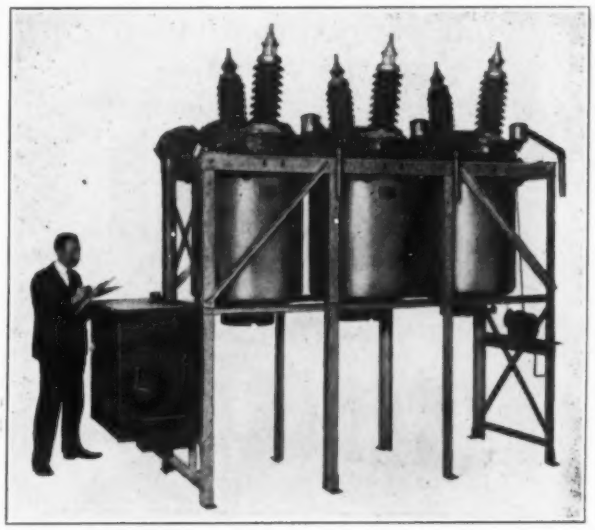
Chicago Office: 205 W. Wacker Drive.
Eastern Office: 21 Park Row, New York
Sales Offices in all principal cities

Canadian Representative Northern Electric Company LIMITED

It pays to use The 'Three E' WRITE FOR *Catalogue*

"Built Like a Machine"

OIL CIRCUIT BREAKERS



Built like a machine with the sturdiness of a punch press

IT IS NEW

IT IS HEAVY

BELIEVE IT OR NOT
This "Built-Like-a-Machine" Oil Circuit Breaker Opened and Closed Over 27,000 Times. And Judging From Its "A-1" Condition Will Probably Go Many Times This Figure

Why Not Come to Chicago and See This Machine Type Breaker?

ASK ANY PUNCH PRESS OPERATOR ABOUT THE LIFE OF PUNCH PRESSES THEN COMPARE PUNCH PRESS AND OIL CIRCUIT BREAKER OPERATIONS

ASK FOR DATA

Delta-Star Electric Co

ASK FOR PRICES

2400 Block, Fulton Street - CHICAGO, ILLINOIS

MOLONEY

TRANSFORMERS

GENERATION
TRANSMISSION
DISTRIBUTION

Performance and economy are the chief things with which the buyers of transformers are concerned. It is significant therefore why those who know specify Moloney Transformers without hesitation.

MOLONEY ELECTRIC COMPANY
Main Office and Factories: St. Louis, Mo.
Sales offices in all principal cities

BHILE—SARP

In India the slightest thing can start a riot.

A Moslem shoe on a naked Hindu foot . . . then "Bhile" (cow eater) from the Hindu and "Sarp" (snake worshipper) from the Moslem, and the fight is on.

Touchiness, a very bad trait, results usually from living under strained conditions. And it is not confined to humans.

A little too much load on a machine equipped with run-of-mill carbon brushes and the sparks and chatter begin.

Morganite brushes, on the other hand, being well-bred, never talk back.

Morganite

Main Office and Factory
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Los Angeles, Electrical Engineering Sales Co., 502 Delta Bldg.
San Francisco, Electrical Engineering Sales Co., 222 Underwood Building.
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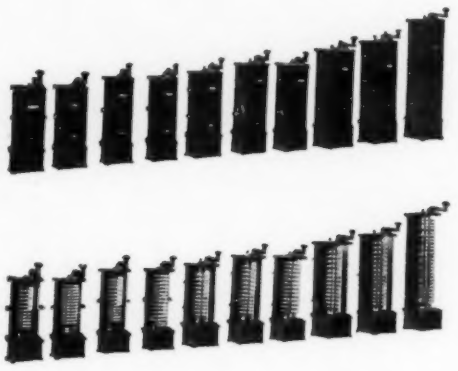
UNION

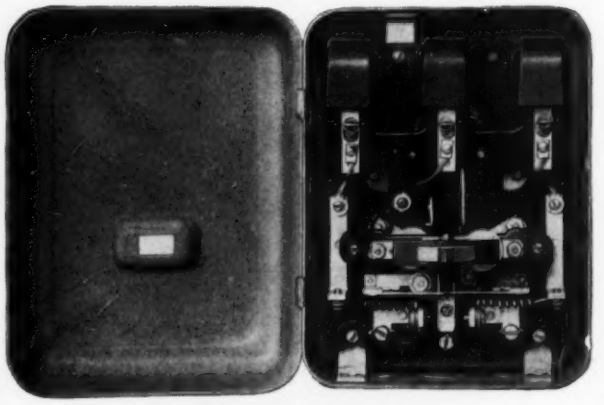
The Most Complete Line of Drum Controllers in the World



Drum Controllers for all General Purposes for Industrial Control Applications. D.C. and A.C.

Also Complete Line Magnetic Switches

20 to 300 Amperes



Standard Features

Across-the-Line Starting.
Two or Three-Wire Control.
Thermal Overload Relay with Interchangeable Elements.
Dust-Proof Enclosing Case.
Removable Bakelite Panel.
Individual Renewable Arc Shields.
Ample Wiring Space.
Knock-Outs in all Directions.
Lever Type Control Switch.
Deep Drawn Box and Cover.

Write for Descriptive Bulletins

UNION ELECTRIC MFG. CO.

938 Juneau Ave., Milwaukee, Wis.

Manufacturers of

Electric Motor Control Apparatus

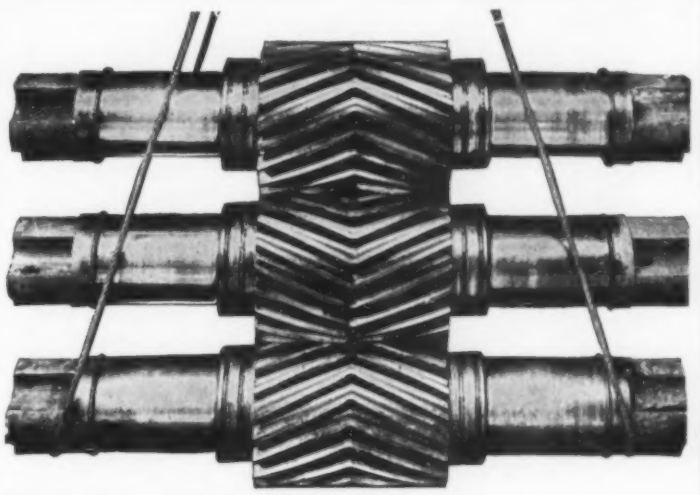
Also Associated Manufacturer with, and Eastern Distributor for
DIAMOND Ⓔ ELECTRICAL MFG. CO., *Los Angeles, Cal.*
Magnetic Motor Control Apparatus

These "TOOL STEEL" Mill Pinions

Cost ---------- **$628.10 each**

Have Saved ---------- **471.07 each**

And Are Still As Good As New



3 Cut Tooth "Tool Steel" Herringbone Mill Pinions, 21 teeth, 1¼ pitch 18" face running on a 3 high, 14" merchant's Mill producing as much as 650 tons in 10 hours.

Pinions installed March 8th, 1922, removed for new bearings after 3½ years of service with no appreciable wear on the pinions.

In this service untreated steel pinions were worn out in one year.

In 3½ years these "Tool Steel" pinions, still without wear, have given life that would have cost them, had they bought untreated material, a total of	$1,099.17 each
The "Tool Steel" pinions themselves cost only	628.10 each
Besides paying for themselves they have made a clean saving of	471.07 each

PLUS 3 extra installation charges, freight and haulage, plus better work produced since the pinions have remained new instead of worn.

The Tool Steel Gear & Pinion Company

CINCINNATI, OHIO

At this Radiant Season of Good Cheer when business cares are overshadowed by good fellowship and kind thoughts, we sincerely wish you an old-fashioned Yuletide, and a New Year abounding with Success, Good Luck and Happiness.

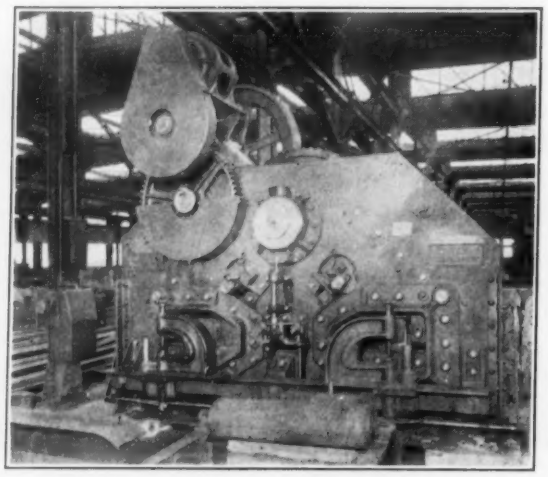
RUMSEY

ELECTRIC COMPANY

Electric Supplies and Machinery
Everything in Radio

1007 Arch Street

Philadelphia



Steel Mill Installation on double ended shear using Rowan Type 9000-B Oil Immersed Impedance Starter.

Type 9000-B Impedance Starters have the following essential features for Steel Mills and other applications.

1—All working parts are completely oil immersed, therefore always lubricated and accurate in operation.

2—Impedance coils located so that they are easily accessible and adjustable.

3—All parts are ruggedly constructed and enclosed in a heavy sheet steel cabinet, carefully welded, making them dust-proof and weather-proof.

4—Completely protects motor against overloads, Short Circuits and single phase operation by means of accurately, calibrated magnetic overload relays which are not effected by ambient temperatures.

Write for further information regarding this Heavy Duty Impedance Starter.

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

Special transformers *but* .. at prices in line with standard equipment

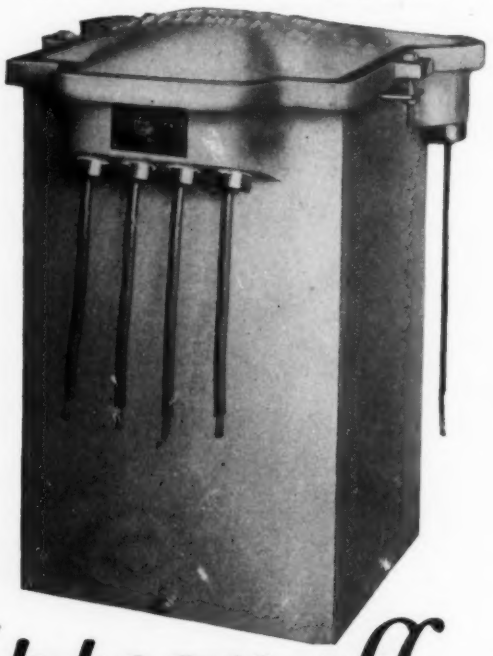
For instance: A special situation comes up in your plant. You require transformers built to your specifications. Stock equipment won't do.

You want these transformers shipped within a reasonable time. Production—the work of men and machines—must not be delayed. Above all, this specially-built equipment must not cost a young fortune. The price must be in line with standard equipment.

It's on this basis, that we are building—and have been building for some years—hard-working transformers for dozens of companies. We'll be glad to work with you on standard or special equipment.

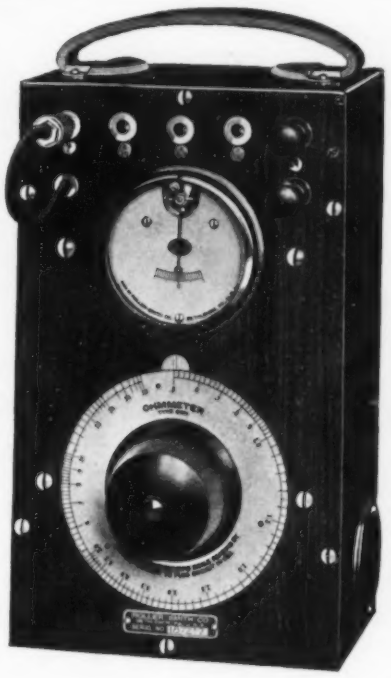
R. E. UPTEGRAFF MFG. CO.

Sales Office
1414 Clark Bldg. Pittsburgh, Pa.



Uptegraff Transformers

Other Transformer Products: Potential - Distribution - Small Power - Testing - Boosting - Furnace - Auto - Motor Starting Auto - Reactance and Balance Coils.



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OHMMETER

Portable, direct reading, small, compact, light, rugged, accurate, entirely self-contained, including the small flashlight cells. Measures resistance values from .5 ohm to 50,000 ohms. Send for new Bulletin No. AK-300.

ROLLER SMITH

HTD
CIRCUIT TESTER

Instantly locates open circuits in coils and circuits. Shows approximate resistance up to 10,000 ohms, 100,000 or 200,000 ohms, according to type selected. Small, compact, rugged and dependable. Send for new Bulletin No. AK-300.

"Over thirty-five years' experience is back of ROLLER-SMITH"

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ROLLER-SMITH COMPANY
Electrical Measuring and Protective Apparatus

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Representatives in Australia, Cuba, Japan and Philippine Islands

DELTABESTON WIRE

Heat Cannot Harm This Magnet Wire

Insulated with pure long-fibre asbestos, Deltabeston magnet wire has increased the dependability of motors in every industry. Deltabeston is heat-proof. Moisture cannot penetrate its walls. It also resists the action of acids and abrasion. Ask for samples; test them, yourself; and learn why Deltabeston is used by so many prominent manufacturers.

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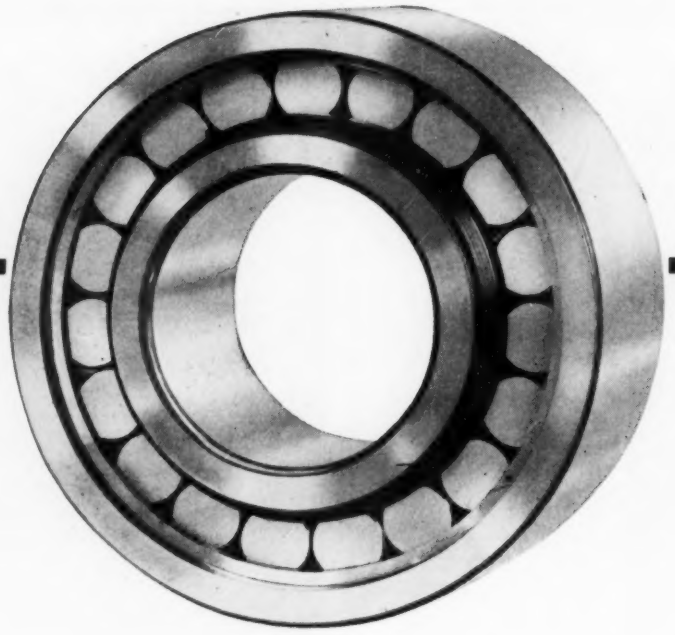


EXPERIENCE

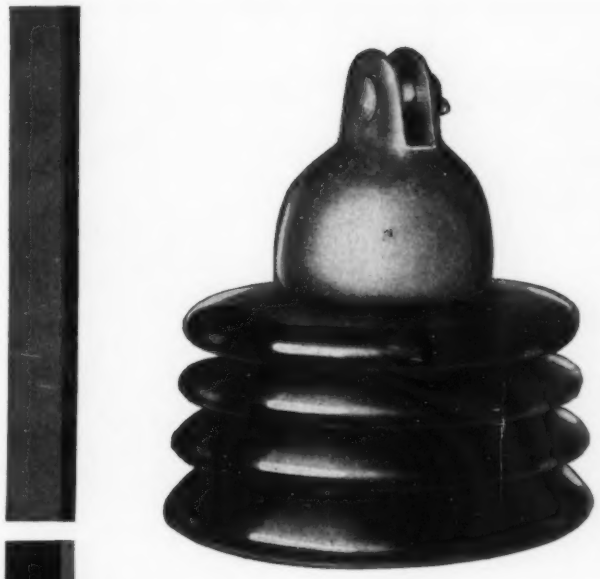
based on knowledge of proved facts is the foundation of all progress.

Nineteen years of engineering experience, with a thorough knowledge of the proper application of bearing principles, is the foundation on which Rollway Cylindrical Roller Bearings are built—the bearings of proved quality.

There is a proper solution to each of your bearing problems. Consult our engineers.

ROLLWAY BEARING
COMPANY INCORPORATED
SYRACUSE NEW YORK

ROLLWAY CYLINDRICAL ROLLER BEARINGS



LAPP INSULATORS

Lapp Fog Type Suspension Insulator, No. 5805. Test voltage, 116,000. Minimum Mechanical and M. & E. strength 12,000 lbs. Flashover wet and dry much higher in strings than standard 10" units.

How They Stand Up!

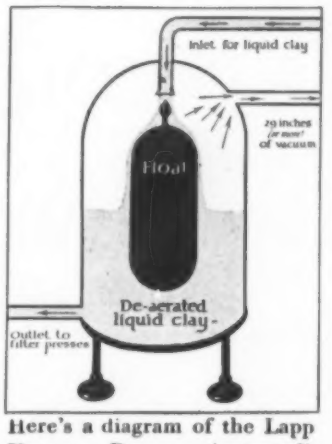
UNDER salt spray deposition, eight Lapp Fog Type Suspension Units hold in while 12 or more standard 10-inch units flash over. This superiority is due to difference in design. And these designs are made possible by Lapp Vacuum Process porcelain (patented).

As on all Lapp Suspension Insulators, the metal parts are *drop-forged* copper-bearing steel, excellently hot-dip galvanized.

Lapp Fog Type Insulators are carring 220,000 volts for Southern California Edison Company. At the other extreme, they are now setting new standards in telegraph service. Lapp Fog Types can probably cite cures under conditions similar to those now menacing your own operations.

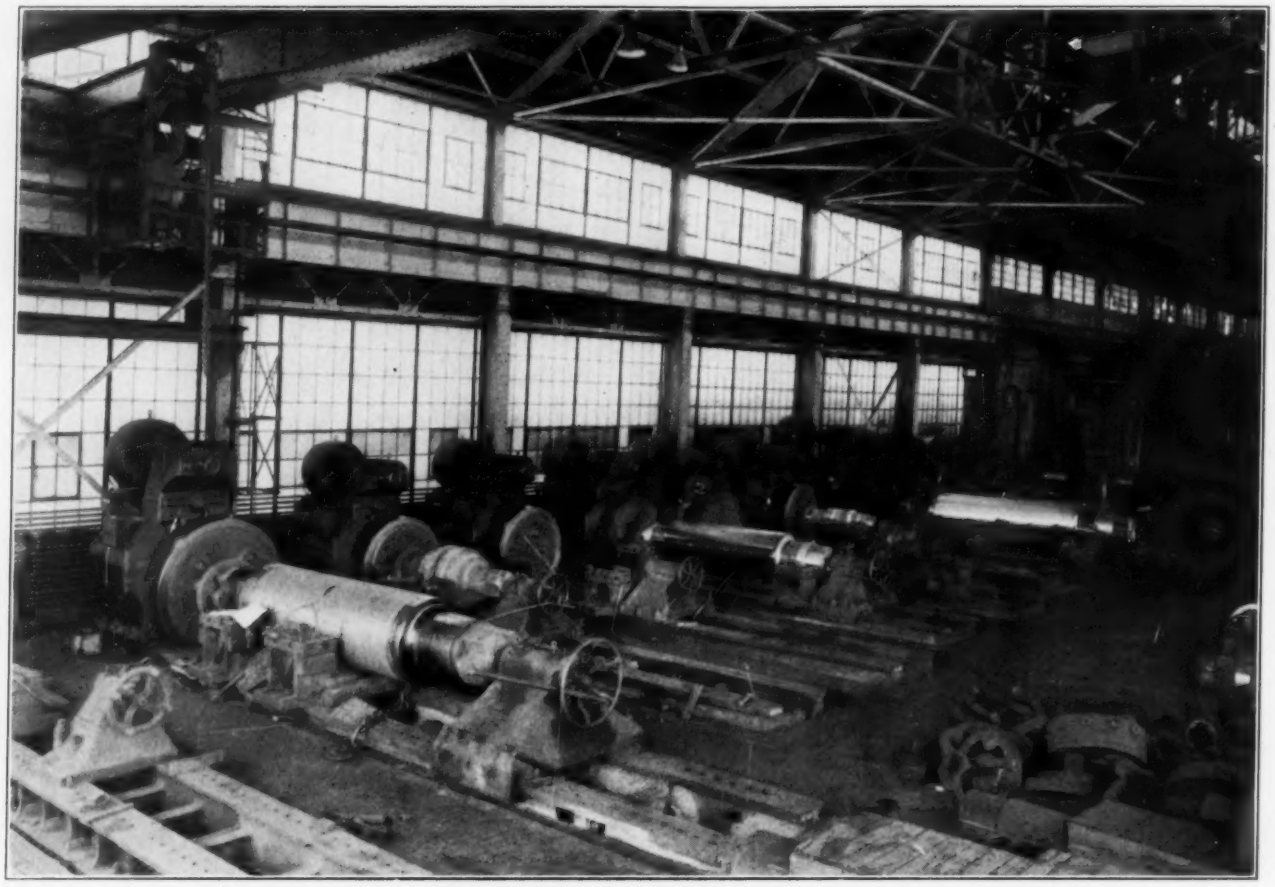
Their short petticoats reduce breakage. Cleaning is required only under the most exceptional conditions. Per year of service, they cost less than standard types, while initial cost is only slightly higher.

Lapp Insulators reduce maintenance costs



Here's a diagram of the Lapp Vacuum Process (patented). Mechanical and dielectric faults are usually due to air occluded in the liquid clay—"slip." The Vacuum Process actually boils the air right out. The resulting porcelain has unique homogeneity and permanence.

LAPP INSULATOR CO. INC. LE ROY · N.Y. · U.S.A.



COLLECT YOUR DIVIDENDS
...IN...
DEPENDABLE OPERATION

The installation pictured above shows EDCO MOTORS which have been giving dependable operation from 10 to 25 YEARS without major repairs at the Canton plant of the United Engineering & Foundry Company.

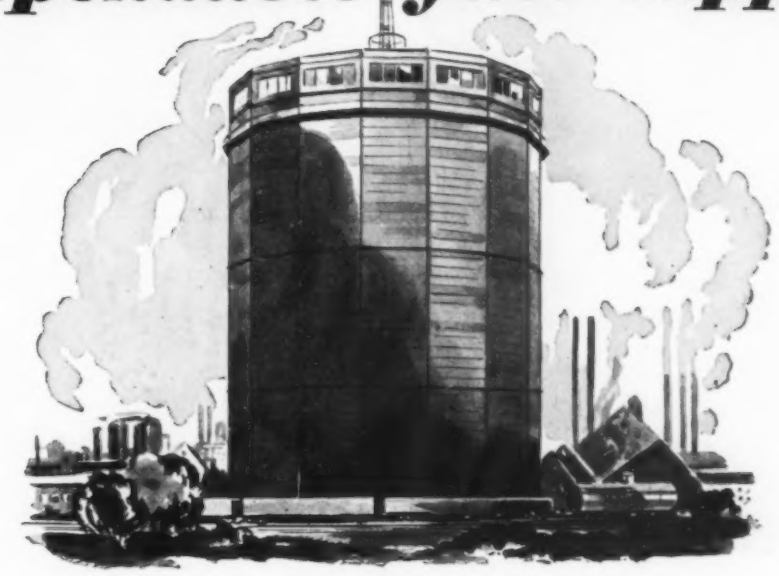
MOTORS FOR ALL APPLICATIONS

Quality for Half a Century

ELECTRO DYNAMIC COMPANY
BAYONNE, N. J.

GAS

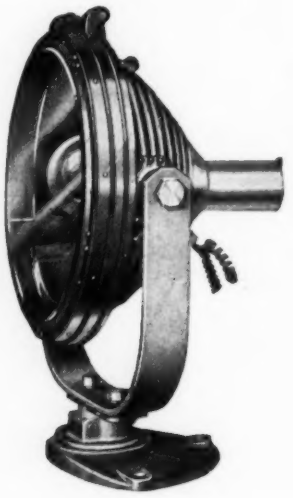
a dependable fuel supply



Today, with the network of intercommunicating gas supply lines, failure of the supply of gas is a very remote possibility. The industrial user of gas is assured of uniform-quality fuel twenty-four hours a day, three hundred and sixty-five days in the year. Can you equal that with any other fuel? ▲ ▲ ▲ ▲ ▲

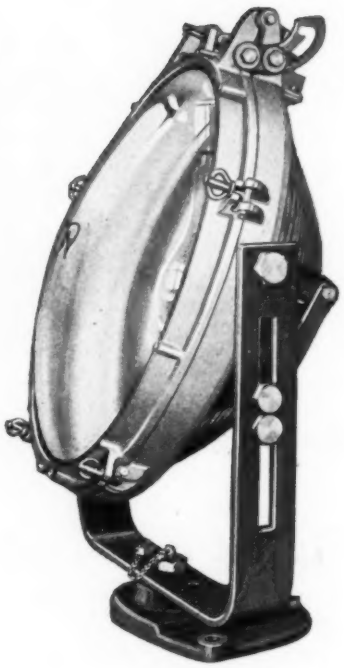
AMERICAN GAS ASSOCIATION
420 Lexington Avenue, New York

If It's Done With Heat
YOU CAN DO IT BETTER WITH GAS



THE remarkable efficiency and permanency of construction of **Pyle-O-Lytes** is the result of years of experience in the building of light projectors. The reflectors have a specially developed curve that projects the light in a beam of remarkable even intensity and with a minimum of stray light. Housings are of rust-proof materials and of an air tight construction to prevent dust and moisture reaching the reflector.

Pyle-O-Lytes are manufactured in sizes of from 10-inch to 23-inch.



Write for Information

The Pyle-National Company

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CHICAGO, ILLINOIS, U. S. A.

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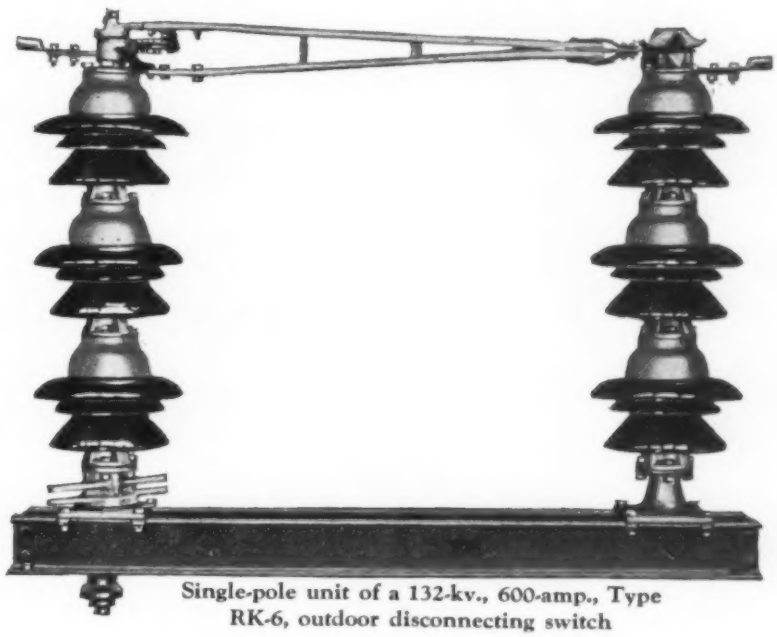
Little Building . . Boston, Massachusetts
Exchange National Bank Bldg. . Tulsa, Okla.
Hobart Building . . San Francisco, California



Single-pole unit of a 132-kv., 600-amp., Type RK-6, outdoor disconnecting switch

Where economy counts, install the Type RK

G-E Type RK side-break outdoor switches are economical because only two insulator stacks per pole and a simple form of operating mechanism are used. They are economical, not only in first cost, but also in installation and maintenance.

These switches have self-aligning, full-floating, spring-pressure line contacts; broken-back blade construction for ice-breaking action; standardized interchangeable insulators; and a main bearing of the ball type which takes thrust in every direction.

G-E Type RK group-operated disconnecting switches are made in ratings of 88 to 154 kv., 600 amperes, single- or double-break, in vertical, upright, or underhung mountings. They are for isolating purposes only. A detailed description is contained in publication GEA-1164, available from the nearest G-E office.

500-44

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

STANDARD Indoor Terminals take various stem parts or lugs

Busbar connections—vertical or horizontal; offset stems for switchboard use; single or double horizontal lugs; no matter what your needs may be—you can specify the *right* Standard Terminals and the *right* combination of Standard stem or lug connections.

Our engineers are practical field men. When you specify Standard products, you can have full confidence that you are using the most recent developments.

Other unusual features of Standard Accessories are the patented bi-metallic nipple, Standard's exclusive oil-tight porcelain insulated joint, the replaceable insulators for all terminals.

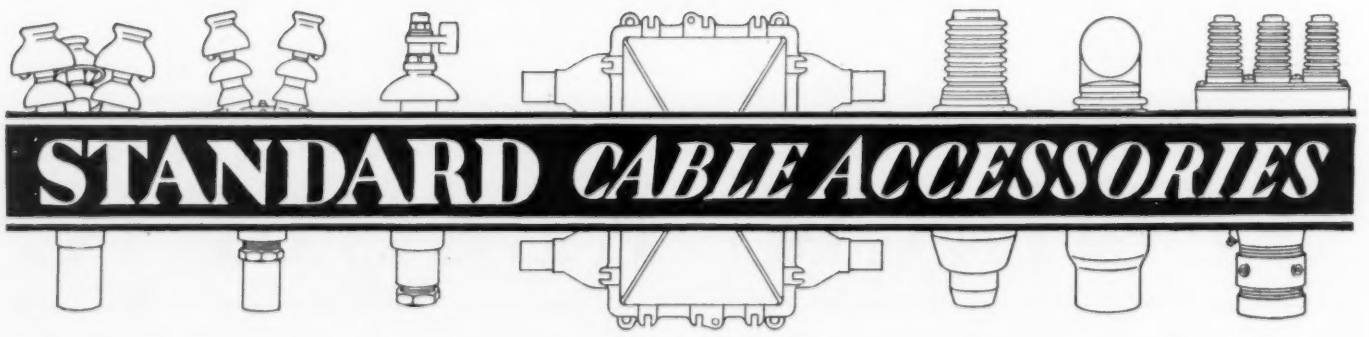
These features are fully described in the four Standard Catalogs on Outdoor Terminals; Indoor Terminals; Junction and Joint Boxes; and Jointing and Miscellaneous Materials. Are you particularly interested in one of the four? Or shall we send them all?

STANDARD UNDERGROUND CABLE COMPANY
PERTH AMBOY, N. J.

SAFETY CABLE COMPANY
NEW YORK, N.Y.

ROME WIRE COMPANY
ROME, N.Y.

Divisions of General Cable Corporation



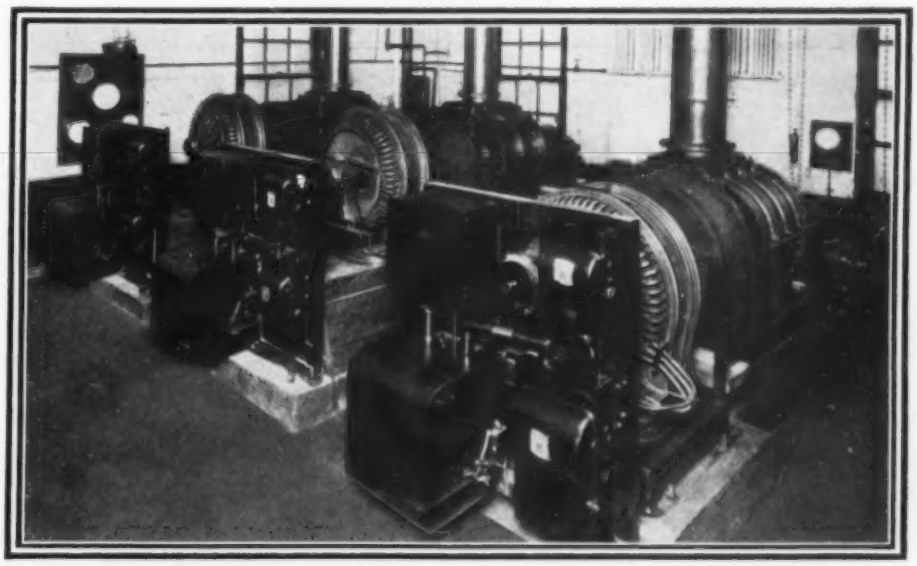
Automatic Control for All Sizes of SYNCHRONOUS MOTORS

SYNCHRONOUS Motors of all sizes . . . small, as well as large . . . are made practical for a very wide range of applications by inexpensive, simple, compact, automatic and semi-automatic E-M Starters. This means that small equipment can be economically driven by small E-M Synchronous Motors.

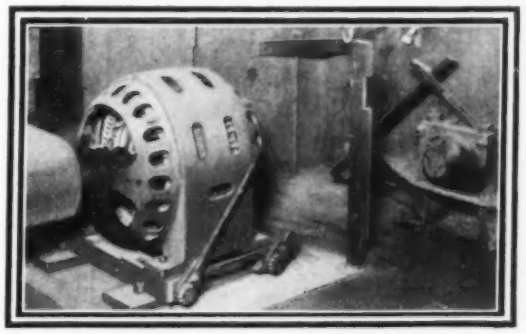
E-M Starters afford automatic control of synchronization. They are fool proof and trouble proof. They provide push-button starting in all but the small, inexpensive sizes. Even with these latter, the attendant need not be skilled, as he performs exactly the same operation as in starting a squirrel-cage induction motor. As a matter of fact, there are many E-M Starters, both automatic and semi-automatic, being operated by men who are not aware they are starting Synchronous Motors . . . do not know the difference between synchronous and induction motors.

E-M semi-automatic starters are compact —as may be seen from the illustrations here. They may be set up near the motor in any convenient location, as shown in (b) and (f), or obtained panel-mounted, as shown in (c). They are inexpensive and their first cost is their *only* cost.

For detailed information, ask for a copy of our 56-page book, "The Most Efficient Drive in Industry."

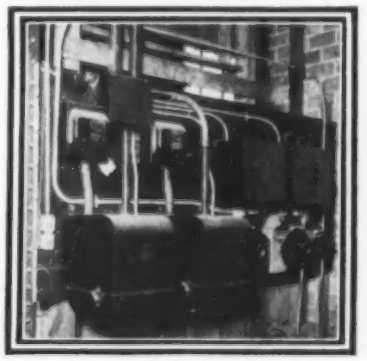


[B] *Two 75 H.P. and one 100 H.P., 300 R.P.M. E-M Synchronous motor-driven blowers at the Consolidated Gas & Electric Co., Baltimore, Md. Note how the E-M semi-automatic controls are installed adjacent to the motors.*



Cinder screen driven by 60 H.P., 900 R.P.M. bracket type synchronous motor at plant of Cinder Concrete Units Corp., Somerville, Mass. The E-M Control for this motor is shown in photograph directly across the page.

[C] *Switchboard type semi-automatic E-M starter. Synchronization is automatically maintained by the field control mounted on the panel. Full automatic starters with push-button operation are available when desired.*



[F] *Semi-automatic, compensator type, reduced voltage E-M Starter for motor at Cinder Concrete Units Corporation shown at left hand side of page.*

Electric Machinery Mfg. Company

Specialists in Apparatus for Power Factor Improvement

1337 Tyler Street, N. E. Minneapolis, Minn.

Sales Offices in Principal Cities

Users of E-M equipment are assured of quick, reliable service by a corps of trained engineers working out of E-M offices in 40 cities. The specialized, quick-moving E-M factory and sales organization is always ready to give you prompt, skilled attention.

EM *Synchronous* MOTORS

THE DEPENDABLE, ECONOMICAL DRIVE OF PROVEN PERFORMANCE

(1017)

BLISS

ROLLING MILL EQUIPMENT
FOR
HOT OR COLD ROLLING

MILLS

MILL REELS

COILERS

SLITTERS

WINDING REELS

LEVELING MACHINES

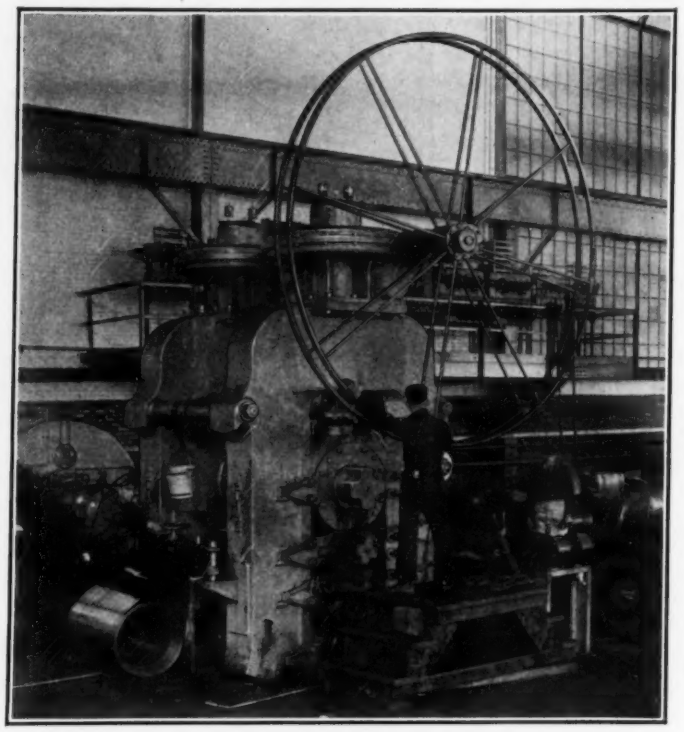
SHEARS

RECOILING MACHINES

SCRAP-BAILING MACHINES

ETC.

ETC.



BLISS FOUR-HIGH MILLS
ROLLER-BEARING EQUIPPED

These mills are built in all sizes and roller-bearing equipped throughout.

Full details on request.

BLISS for MACHINERY

E. W. BLISS CO., BROOKLYN, N. Y., U. S. A.

Factories: BROOKLYN, N. Y. HASTINGS, MICH. SALEM, OHIO

Sales Offices: DETROIT CLEVELAND CHICAGO ROCHESTER PHILADELPHIA CINCINNATI NEW HAVEN BOSTON

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BLISS

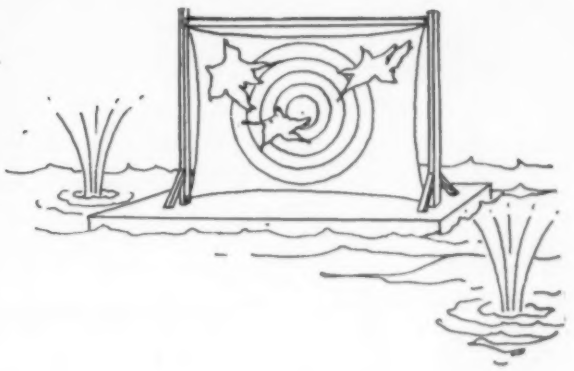
No. 578

Unseen ACCURACY

WARSHIPS in battle formation—target rafts towed far off on the horizon unseen to the naked eye—big guns trained by telescope—then bang goes a broadside salvo to find their mark in the distant canvas bull's-eyes—Unseen accuracy, yes—but the result of perfect military precision and co-ordination of an entire ship's crew.

The same precision—the same accuracy and coordination is practiced by the Stackpole organization in the production of carbon brushes.—Behind each Stackpole Brush is the unseen accuracy of an army of skilled employees under the scientific supervision of carbon experts.

The result is a perfectly uniform line of high grade carbon brushes, every one of which makes a "bull's-eye" in longer service, better commutation and greater efficiency throughout industry.



STACKPOLE CARBON CO.
ST. MARYS, PENNA.

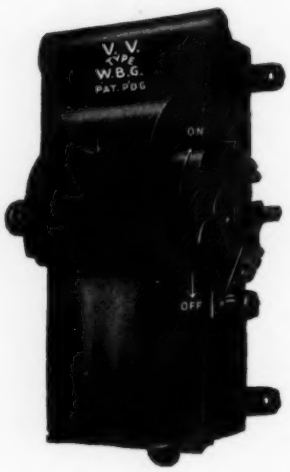
Stackpole carbon brushes

QUICK POSITIVE MAKE
QUICK WIDE BREAK

30-60-100
200-400-600
Ampere

—

V.V.
Sturdy
Construction



250-
600
Volts.

—

V.V.
Mechanical
Perfection

Cast Iron—Type WBG—Weatherproof

WITH THE USUAL V. V. SAFETY FEATURES

V. V. FITTINGS COMPANY

New York
50 Church St.

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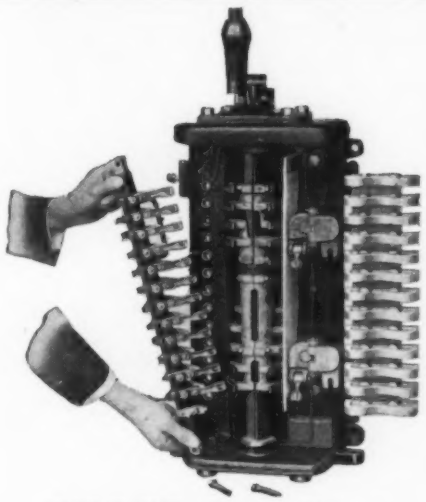
710 W. Jackson Blvd.

Pittsburgh Representative
P. H. Schaum
422 Duquesne Way

Detroit Representative
Thos. R. Buchanan
138 E. Congress St.

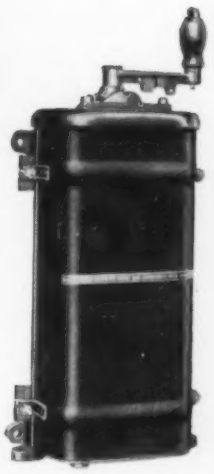
Just what part of "control" can you afford to slight?



C-H Full Reversing Drum Controller—Bul. 5300

For general reversing service—especially efficient on cranes and hoists. Speed reduction varies with load—50 per cent on average load. Auxiliary contacts, incorporated in standard drum, provide limit switch protection.

Typical C-H construction using all steel finger board, rolled bar copper contact segments, pivoted non-stubbing contact fingers, drum cylinder assembled on insulated steel shaft, and with all wearing parts quickly, easily renewable. Completely enclosed in asbestos-lined case for safety to men and mechanism. Approved by Underwriters.



Exterior view of C-H Drum Controller showing asbestos-lined sheet metal cover used on Bul. 5300 (at left).

A MOTOR control system extends from the operator to his machine. The accessory units in this system may seem comparatively unimportant . . . "any old thing will do."

But as far as continuous production is concerned, each unit has to shoulder responsibility equally. The accessories must be selected with the same care which is used in selecting the motor and control board. Otherwise, unnecessary delays, repairs and maintenance will eat large holes in production and profits.

For an unvaryingly high standard of performance, maintained over many years . . . for freedom from trouble, costly tie-ups, maintenance and repairs, specify Cutler-Hammer Drums and Masters. These accessories have been developed as a part of, and along with, the Control equipment which has become famous throughout the world. 30 years' intimate concern on the part of C-H Engineers with all problems of Motor Control, assures the highest standard of design, material and workmanship in C-H Drums and Masters.

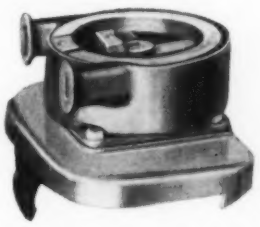
A letter will bring full information as to C-H Drums and Masters . . . or will enlist the cooperation of C-H Engineers in solving your Control problems.

CUTLER-HAMMER, Inc.

Pioneer Manufacturers of Electric Control Apparatus

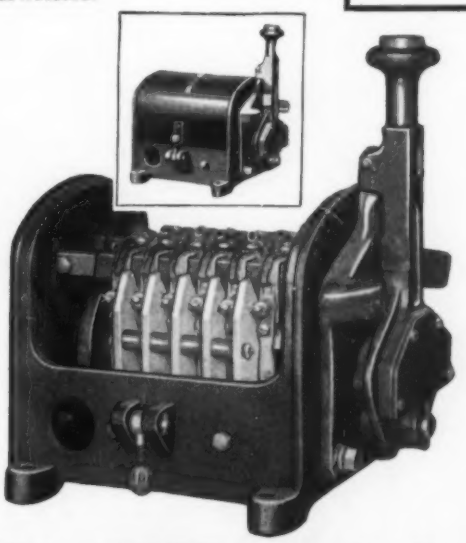
1264 St. Paul Avenue

MILWAUKEE, WISCONSIN



Interchangeable Drives

Head for C-H Drum Controller furnished with rope drive. Other drives either radial lever, straight line lever, or duplex are easily substituted.



C-H Multi-Speed Vertical Drive Master

Straight line drive makes operation easy. Provides as high as five speeds in each direction, with twelve fingers maximum. Extremely compact—yet all parts are readily accessible for inspection or maintenance.

CUTLER HAMMER

Electric Motor Control Accessories

(8685)

COMPARISON Favors Union Fuses Longer Service . . Speedier Renewals

UNION Renewable Fuses are built to stay in service longer . . . and simplified in design to insure speedier renewals.

Unusual strength and quick pressure release enables Union Fuses to withstand more blowouts —thus cutting down yearly fuse maintenance costs.

The casing is made of extra heavy grey horn fibre—vented by an exclusive method which quickly relieves the pressure developed when the fuse blows. Both end cap and steel threads are protected from molten metal—quick disassembly and reassembly are assured.

In the knife-blade type, shown above, links are notched at both ends. Replacement is made simply by loosening the holding studs a trifle. In the ferrule type, links are bent at one end, providing speedy renewals.

Specify Unions on your next fuse order. The comparison will prove their superiority in longer service and speedier renewals, as well as dependable protection.

JEFFERSON ELECTRIC COMPANY
1517 West 15th Street Chicago, Ill.

FREE FUSE CHART

For your convenience, we have prepared a quick-reference fuse chart which tells at a glance the proper fuse to use for every type of motor. A copy will be mailed on request. Also ask for a copy of Catalog No. 33, showing complete line of Union Fuses.

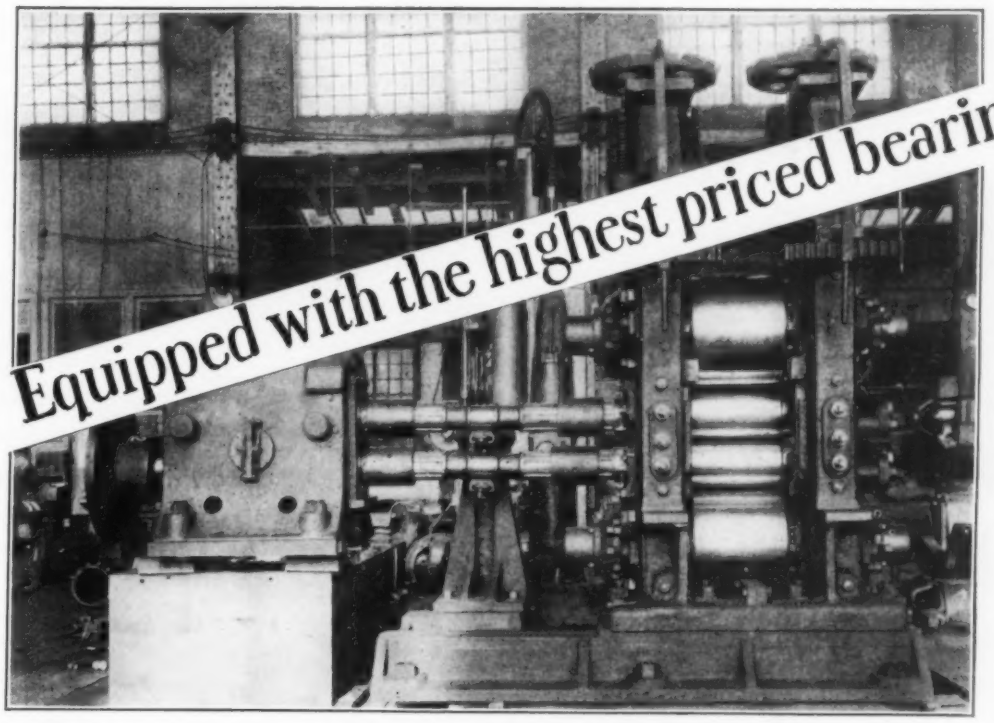
UNION FUSES

Because they are worth more they really cost less

(8909)

ANOTHER APPLICATION OF SKF BEARINGS IN THE STEEL MILLS OF AMERICA BY THE

United Engineering and Foundry Company



YOU MAY BUY A BEARING AS A BARGAIN BUT TRY AND GET A BARGAIN OUT OF USING IT

for

Nothing is apt to cost so much as a bearing that cost so little.

SKF Puts the Right Bearing in the Right Place

It Doesn't Take Long to Show the Value of SKF Bearings on the United 4 High Mill

AMONG the many advantages which feature this United 4 High Mill, one SKF Self-Aligning Roller Bearing on each neck of the top and bottom back-up rolls, plays an important part. Six of these stands are now successfully operating in a steel mill and one of the outstanding characteristics of the bearing installation is the inherent property of self-alignment in each SKF Bearing. This permits equal load distribution over both rows of rollers without cramping, assuring maximum carrying capacity and bearing life.

SKF Bearings do their share in reducing power costs, increasing output per man and reducing production costs per ton. Why they do this is readily evident for bearing friction is reduced to a minimum and maintenance is a negligible factor. SKF precision remains unchanged under the hardest work and bearing adjustments are never required. Added to this is their long-life and ruggedness which made SKF truly lowest in cost per bearing hour.

SKF INDUSTRIES, INC., 40 East 34th Street, New York, N. Y. 2422

SKF

Ball and Roller Bearings

"Just what I need for a Color Scheme"

Illustration from Bulletin 607

ELPECO FACETED LENSES

This engineer and contractor was commenting on the fact that he was enabled to get lenses of many colors in addition to standard red and green for his color indications.

Whenever color indications are required, such as on control switches, signal switches, safety switches, oil switch indicators on cell switches, switchboard indicators, bus potential indicators—the Elpeco Faceted Lens will be a help to you in this way.

It gives you a scientifically faceted lens to diffuse rays in all directions.

It gives you natural glass tints—not a lacquered job.

It gives you a clamping shell that is fully ventilated for long life of lamp.

The Elpeco bulletin 607 will give you many suggestions.

Write for a copy.

for the good of the Service

CARRIED IN STOCK

ELPECO
ELECTRIC POWER EQUIPMENT CORPORATION
412-420 NORTH EIGHTEENTH ST. PHILADELPHIA, PA.

THE TEST OF TIME

Applied to an Air Filter

Phoenix "Constant Effect" is the pioneer self-cleaning air filter—by a big margin of time—and still the standard of comparison in its field.

It has never been found necessary to deviate from the original basic principle—a tribute to the soundness of the Phoenix design.

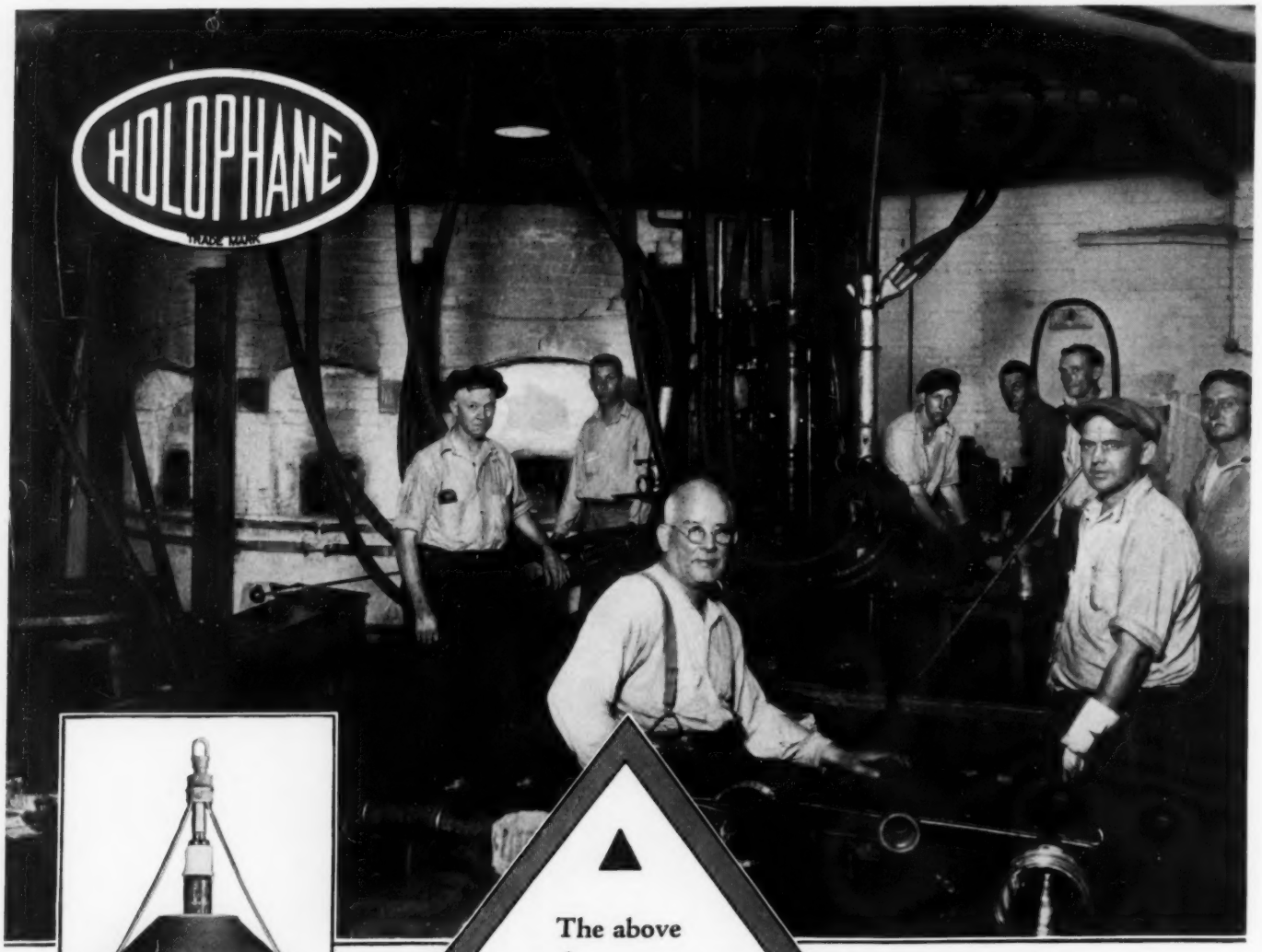
Here is a PHOENIX "Constant Effect" Air Filter
built into a solid brick wall five years ago.

Endurance is characteristic of both filter and wall

"Food for thought to the Engineer who is called upon to make a large investment in Air Filters"

NATIONAL AIR FILTER COMPANY
INCORPORATED

205 CENTRAL AVE. LOUISVILLE, KY.



The above photograph shows how Holophane "Hibay" lighting units are tested at our factory for actual service conditions. The No. 691-AL "Hibay" unit was hung 4 feet above one of the glass furnaces, lamped with a 1500 watt 220 volt lamp and burned continuously for 2½ months. The lamp burned 10% above normal life of 1000 hours. No trouble of any kind developed. Severe tests of this kind insure Holophane Industrial Specifics against defects of mechanical design.

Highest possible efficiency and rigid mechanical design are characteristic of all Holophane Industrial Lighting Specifics.

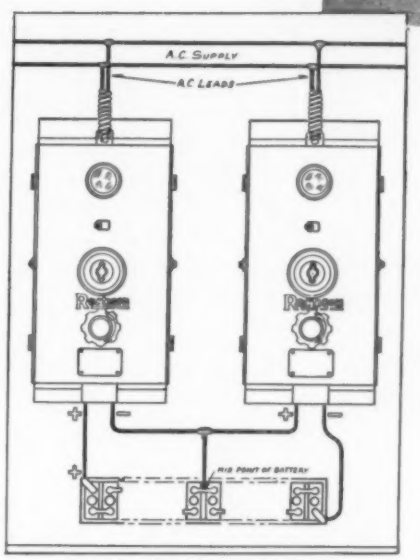
HOLOPHANE COMPANY, Inc. - 342 Madison Avenue, New York

HOLOPHANE

SAN FRANCISCO
PHILADELPHIA
HARTFORD
CHICAGO
BALTIMORE
BIRMINGHAM
CLEVELAND
MILWAUKEE
ST. LOUIS
LOS ANGELES
CINCINNATI
TORONTO
SYRACUSE
BOSTON

D.C.

for circuit breakers . . pilot lamps . . exciting D. C. generators



60 cells lead acid storage battery

Where batteries are subject to a high current drain this Westinghouse Rectigon, Style Number 571306, gives the charging capacity you need. High or trickle charge rate — whichever is needed — is quickly obtainable from this outfit by means of the dial switch conveniently located on the front panel. An ammeter is also permanently mounted at the top of the front panel to indicate the charging current being supplied to the batteries.

This Rectigon charges from 1 to 45 cells of lead storage battery at a maximum rate of 6 amperes. Two Rectigons, connected as shown in the diagram, have a maximum charging rate of 6 amperes at 200 volts, D. C. In emergencies they can be operated for short periods of time at a maximum charging rate of 7 amperes. Two Rectigons may be wired as shown, or a unit can be supplied, mounted in a single case with all wiring connections made internally.

Rectigons do not require starting devices, reverse current relays or no-load protection relays. No harm is done to the batteries or charger if the line voltage fails. Charging starts immediately when the circuit is re-established.

Rectigons have a high efficiency that remains constant throughout the life of the unit. There are no moving parts to wear or deteriorate . . . nothing to replace but the bulb which must be renewed at infrequent intervals.

Let us explain how Westinghouse Rectifiers . . . Rectox and Rectigon . . . can help you where you need direct current from an alternating current supply. Send in the coupon today.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
Rectifier Section East Pittsburgh, Pa.
Sales Offices and Service Shops in All Principal Cities

Westinghouse

Westinghouse Electric & Manufacturing Company,
Rectifier Section,
East Pittsburgh, Pa.

Please supply information about Rectigon and Rectox Rectifiers:

Name.....

Company.....

Address.....

City.....State.....

A "Proving Ground" For Steel Mill Bearings

ROLLING MILL UNIT

35" Mill

Ingot Transfer Table.. Approach Table Side Shaft.. Run-out Table Side Shaft.. Lifting Table Side Shaft.. All Table Rollers.. Shear—Approach Table Rollers.. Shear—Approach Table Side Shaft.. Shear—Run-out Table Rollers.. Shear—Run-out Table Side Shaft.. Transfer Table—Gear Drive and Sprocket and Idler Sheaves.

28" Mill

Mill Roll Necks.. Top and Bottom Screwdowns.. Gear Drive.. Pinion Stand.. Tilting Transfer Tables—Rollers and Drives.. Run-out Table—Rollers.. Side Shaft on all Tables.

22" Mill

Mill Roll Necks.. Pinion Stand.. Gear Drive.. Rope Type Bloom Transfer, Drives, Drum Shafts and Sheave Wheels.. Approach Tables—Gear Drives, Rollers and Line Shafts.. Run-out Tables—Gear Drives, Rollers and Line Shafts.. Tilting Tables—Gear Drives, Rollers and Line Shafts.. No. 150 Billet Shear Drive.

TUBE MILL UNIT

36" Piercing Mill

Mill Roll Necks.. Gear Drive.. Table Rollers for Run-out Table.. Side Shaft for Run-out Table.. Pierced Billet Conveyor—Rollers.

28" Automatic Rolling Mill Roll Necks.. Gear Drive.

26" Reeler

Roll Necks.. Gear Drive.. In-going Table Rolls.

Sinking Mill

Roll Necks.. Gear Drive.

MERCHANT MILL

Roll Necks on all Stands.. Gear Drives—Pinions and Gear Shafts.. Approach Table—Side Shafts and Rollers.. Transfer Shafts.. Run-out Table Shafts and Rollers.. Rotary Flying Crop Shear, Upper and Lower Cutterheads.

HOT SAWS

48" Hot Saw

Saw Arbor.

60" Hot Saw

Saw Arbor and Motor Shaft.

HOT BEDS

Flat Bed Skid Type

Transfer Shafts.

264 Foot Hot Bed

Side Shafts.. Table Rollers.

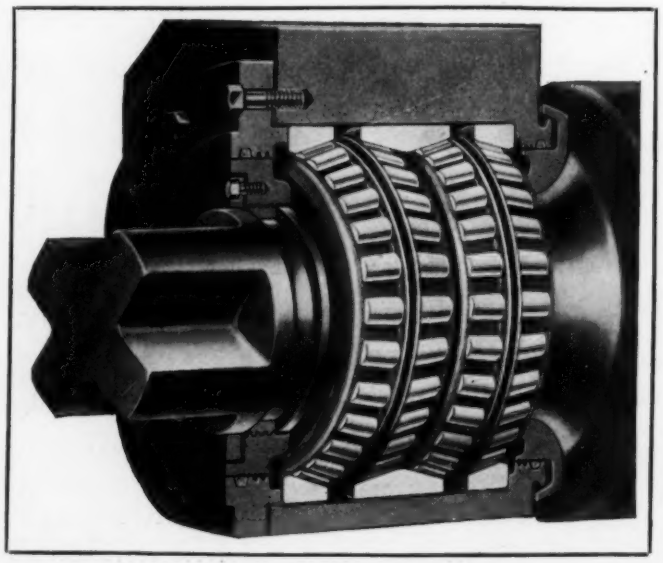
The Timken Steel mills function as a proving ground and testing laboratory for Timken Bearings for steel mill service. The bugs are ironed out before Timken Bearing mountings are recommended for installation in outside mills.

Only by the ability to conduct such thorough experiments can any bearing manufacturer give steel companies the service to which they are entitled, and which they have a right to expect.

Thus, Timken economies... such as power savings of 30% to 50% on roll necks... are available to any steel company... with the assurance that the recommended design provides for continued performance and lasting endurance.

THE TIMKEN ROLLER BEARING COMPANY
CANTON, OHIO

TIMKEN
Tapered
ROLLER BEARINGS



FURNACES

Continuous Re-heating Furnaces

40 ton Continuous Bloom Furnaces; Gear Drive for Table Rollers.. Run-out Tables—Rollers and Side Shafts.. Disappearing Stops.. Gear drive and Rack Mechanism for Double Furnace Pusher.

20 ton Continuous Billet Furnaces; Drive for Pinch Roll Pusher at Discharge End.

30 ton Continuous Billet Furnace; Charging Pusher Mechanism.. Charging Table Rollers.. Run-out Table Rollers.

Annealing Furnaces

700 KW Pusher Type Normalizing Furnaces; Pusher Mechanisms — Longitudinal and Transverse.. Driving Motors for Pushers.. Gear Drive for Run-out Table.. Driving Motor for Run-out Table.. Run-out Table Rollers.

CRANES

Standard Hoist Type

5 ton.. 6 ton.. 10 ton.. 15 ton.. 20 ton.. 35 ton.. 50 ton; Trolley Drive Shaft.. Hoist Shaft.. Bridge Motion Shaft.. Gear Drives—All Motions.. Track Wheels, Sheaves, and Hook Blocks.

Special Type

7 ton Soaking Pit Cranes; Trolley Drive Shaft.. Bridge Motion Shaft.. Gear Drives—All Motions.. Tongs Lowering, Lifting and Turning Shafts.. Track Wheels.

165 ton Ladle Cranes; Trolley Drive Shaft.. Hoist Shaft.. Bridge Motion Shaft.. Worm Gear Drives—All Motions.. Track Wheels, Sheaves and Hook Blocks.

CHARGERS

5 Ton Floor Type

Trolley Drive Shaft.. Ram Drive Shaft.. Ram Turning Shaft.. Bridge Motion Shafts.. Worm Gear Drives—All Motions.. Track Wheels.

CARS

Ingot Cars

Wheels.

Charging Box Cars

Wheels.

INGOT CHARIOT

Track Wheels.. Table Rollers.. Side Shaft.. Gear Drives.

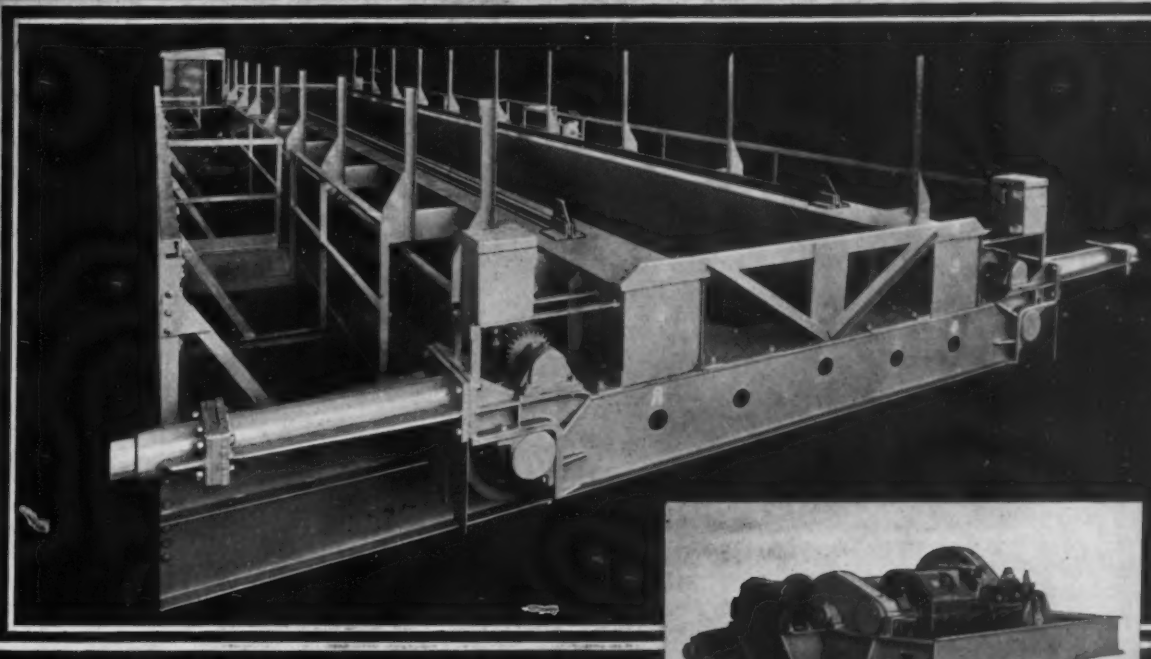
INDUSTRIAL HAULAGE LOCOMOTIVES

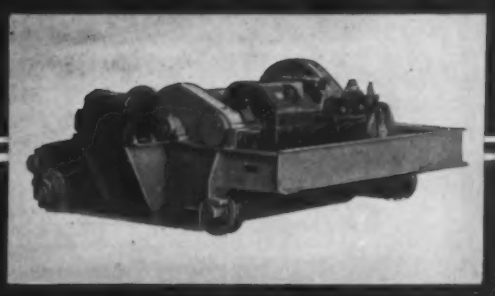
Gasoline Engine-Driven

Wheels.

Gas-Electric

Generator Armature Shaft.. Motor Armatures.. Gas Engine Governor.. Journals.





CLEVELAND
sets the standard by which all cranes are measured . . .

THE greater rigidity and strength of Cleveland cranes set the standard by which these important factors in all crane construction are measured. It is the arc-welded steel construction of trolleys, end trucks and bridge girders that gives Cleveland cranes the superior strength and rigidity to withstand the shifting stresses of moving loads.

The faster acceleration and the smoother operation of Cleveland cranes also set the standard by which these important operating factors of all cranes are determined. The use of roller bearings throughout, and their most efficient application made possible by arc-welded steel construction, impart to Cleveland cranes these superior operating features which mean a saving of power, perfect lubrication and less maintenance.

Manufacturers of CLEVELAND TRAMRAIL SYSTEMS

The Cleveland Crane & Engineering Company, *Wickliffe, Ohio*

50 Church Street, New York City — 512 Farmers Bank Building, Pittsburgh, Penna. — 559 Railway Exchange Building, Chicago, Illinois

CLEVELAND CRANES

All Sizes for Every Service

ASBESTOS-PROTECTED *Motor Windings*

An *Improved* principle in Motor design

‘‘‘‘ adds *Years* to motor life

The many repair shops engaged in re-winding motors furnish proof of the continuous carbonization of motor windings. But you will seldom see U. S. Motors under repair in any shop. These motors successfully resist failure from carbonization to an unusual degree.

While there is no way of protecting motors to guarantee PERPETUAL life, there is a method of insulating the windings so that the life will be infinitely increased and the danger of breakdown minimized.

Asbestos-protected windings in U. S. Motors definitely accomplish this result.

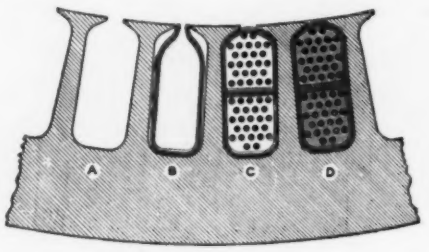
There is only one thing that ‘‘burns out’’ in the windings of a motor. *It is the insulation.* Materials commonly used for insulation include varnished cloth, oiled linen, paper, fibre, insulating varnish, etc., but all of these will carbonize. *None is fireproof.* Even the best of these materials will deteriorate under temperatures at which motors are often called upon to operate. When insulation carbonizes, it is chemically changed from an insulator to a conductor, and destruction of the windings is threatened. Rewinding electric motors is expensive, frequently costing 60% of the price of a new motor, to say nothing about the cost of shut-down.

U. S. engineers developed Asbestos insulation and Asbestosite to replace carbonizing materials. Asbestos is a fibrous rock that has not changed in character or formation for thousands of years, and is the only known fibre that is absolutely incombustible.

Asbestosite, an impregnating compound, is a derivative of asbestos. Each wire is isolated from every other wire by a coating of this heat resistant.

The ability to withstand carbonization at high temperatures means that under normal conditions the risk of ‘‘burn-out’’ is minimized and many years are added to motor life. The exclusive right to the use of Asbestosite in electric motors is controlled by U. S. Motors.

Installation of U. S. Asbestos protected Motors in any plant will go a long way toward assuring uninterrupted operation.



Asbestic Process

A—Empty stator slot before insulating and winding.

B—Formed cell of asbestos providing a heat-proof wall of insulation inside the full length of the slot.

C—Cross section showing wires inserted, with asbestos cell covering the entire winding. In the center of the slot is shown Asbestos plate-board separating and insulating between coils inside every slot.

D—Asbestosite (indicated in color) forced into the slot windings, penetrates every interstice, sealing off the windings with a non-carbonizing insulation.

The U. S. patented process for inductively isolating each wire during impregnation is described in a bulletin entitled ‘‘ASBESTOS PROTECTION.’’ *It will be sent by any distributing office below.*

¼ H. P. to 125 H. P. RATINGS
Horizontal and vertical motors of many types for modern industry.

U. S. ELECTRICAL MFG. CO.

DISTRIBUTING OFFICES

ATLANTA, GA.	HONOLULU, T. H.	PITTSBURGH, PA.
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COLUMBUS, OHIO	MEMPHIS, TENN.	SPOKANE, WASH.
247 N. Front St.	267 Adams Ave.	S. 167 Wall St.
DALLAS, TEXAS	NEW ORLEANS, LA.	ST. LOUIS, MO.
309 N. Market St.	527 St. Joseph St.	731 S. Fourth St.
DENVER, COLO.	NEW YORK, N. Y.	SYRACUSE, N. Y.
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208 San Francisco St.	16 N. 2nd Ave.	1260 Hamilton Ave

U. S. MOTORS

‘‘‘‘ASBESTOS PROTECTED‘‘‘‘

"We can't shut down Number Six! Get it running!"

ANY MAN who puts old-type flexible couplings in a plant is flirting with disaster.

Shut-downs cost money. One machine often stops a whole plant operation.

But as long as machines are connected by couplings made with flexible pins, bushings, springs, discs or grids that fatigue and fail—shut-downs for repairs are bound to get you!

Banish Shut-downs

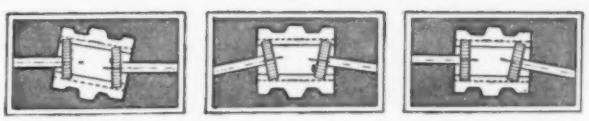
It is all so unnecessary. Thousands of plants have banished shut-downs forever by equipping direct-connected machines with Fast's Self-Aligning Couplings.

From huge rolling mill drives down to 1-inch shaft pumps, fans and other machinery, Fast's coupling absolutely eliminates all chance of failure—because it has no flexible members to fatigue or fail, nothing to wear out, nothing to be replaced.

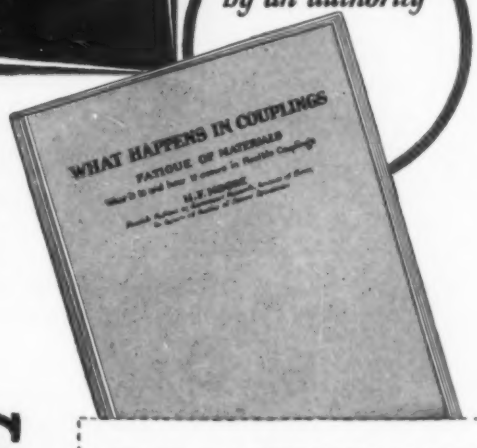
Start to Stop—Now!

Stop future shut-downs for coupling repairs by seeing to it that all new machinery is equipped with Fast's Couplings. Start now by replacing (before it breaks down again) the most troublesome drive in your plant—and prove what Fast's Mechanical Flexibility means.

Send for Free Book by an authority



Two spur gears, one on each shaft end, are completely and continuously meshed in oil with the internal gears of a floating sleeve. The shafts and sleeve revolve noiselessly as one unit, allowing free angular and lateral movement.



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Get this authoritative book. It's free. Learn how and why Fast's Flexible Coupling banishes coupling failures forever.

FAST'S
Self-Aligning
COUPLING

The coupling without flexible bushings, pins, springs, discs, grids or any other flexible materials.

THE BARTLETT HAYWARD COMPANY
211 Scott Street - - - - BALTIMORE, MD.

Please send me the Free Book by Prof. Moore

Company.....

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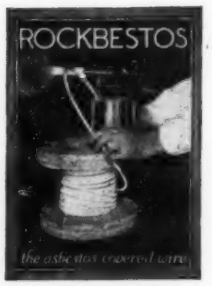
HEAT!

A large rail mill with four Crocker-Wheeler Mill type motors, all safeguarded with ROCKBESTOS

Shutdowns are expensive!

Eliminate those caused through failure of electrical insulation by using ROCKBESTOS, the asbestos insulated wire that is unaffected by high temperatures and all the other destructive conditions met with around equipment such as in the rail mill shown here.

The Crocker-Wheeler Electric Manufacturing Company have long recognized the superior qualities of ROCKBESTOS insulation and safeguard their equipment and assure its continuous operation by using it.

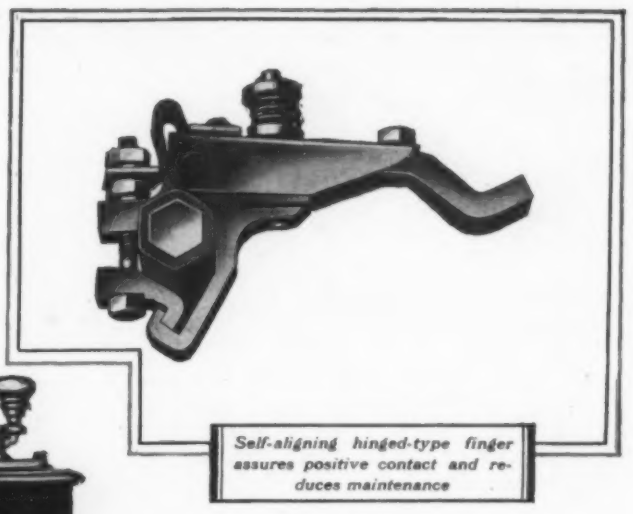


ROCKBESTOS PRODUCTS
CORPORATION
NEW HAVEN, CONN.

5942 Grand Central Term. Bldg., New York — 903 Clark Bldg., Pittsburgh, Pa. — 716 Madison Term. Bldg., Chicago

On the Pacific Coast—Anaconda Wire & Cable Co.

Operating handles—vertical, horizontal, or rope-operated with spring return—are interchangeable



Self-aligning hinged-type finger assures positive contact and reduces maintenance

Strong-easily maintained-safe G-E Drum Switches

RIGID frames of great strength; removable covers for easy access to all parts; conduit boxes which permit leads to enter from back, front, or sides; easily operated; totally enclosed; thoroughly safe—these are among the features which have made G-E drum switches leaders in the industrial field.

The cylinders can be removed for repair or replacement without disconnecting a single wire; and self-aligning hinged-type fingers with easily renewable tips afford long life and even contact regardless of wear.

Controllers
–guide and conserve industry's power

301-45

JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

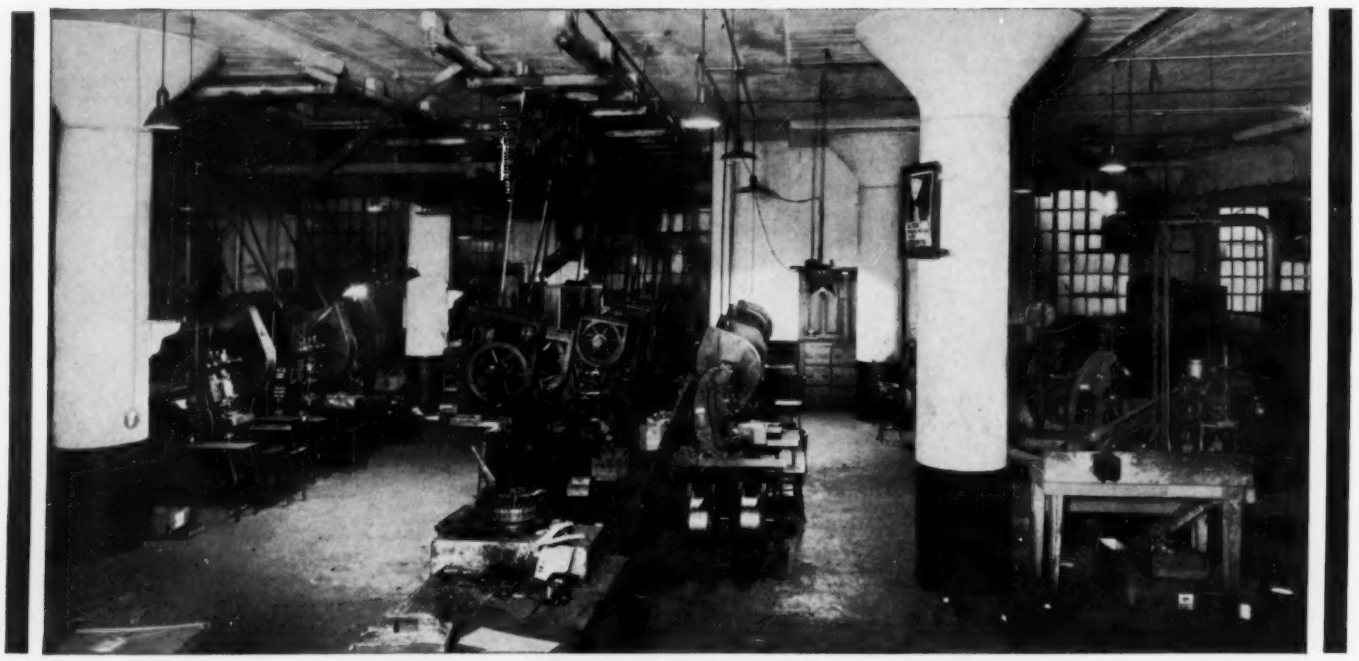
GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

◆◆ BEHIND THE PYRAMIDS—12 ◆◆

N C C

Making BRUSHES exactly to your specifications



Machines for attaching shunts. Plating room in background

MANY National Pyramid Brushes are supplied with shunts, and where necessary are copper plated at the point of attachment to insure a low resistance contact between brush and shunt.

This work is done entirely in our own factories. After the brushes have been sawed and ground to exact size additional special machine operations are performed preparatory to attaching the shunts. Our styles of shunts are standard and meet all requirements of the electrical industry.

The distinguishing visible feature of each shunt is the Silver Strand Cable. This is one of our registered trade-marks, just as much an identification of National Pyramid Brushes as are the letters NCC and the three pyramids. As you pass through power plants, factories, mines and industries the country over, look at the electrical machines. It will not be necessary for you to ask what brushes are being used. The Silver Strand Cable is easily discernible, regardless of how much of the brush itself may be concealed by the brush holder.

The final operation before shipment is a rigid test and inspection. Tests are made for connection resistance, between shunt and brush. Size, angles of bevels, length of shunt and any other special items on the original order, are all checked and verified. Brushes are then carefully wrapped and packed for shipment.

This ends the manufacturing history of National Pyramid Brushes. Over 65 days have been consumed. At least 36 major operations have been performed. Innumerable minor processes have been applied. Scientific tests and controls have been applied constantly. Short cuts have been avoided. And thus the performance of National Pyramid Brushes is safeguarded and the uniformity of grade assured.

An interesting moving picture film illustrating in detail the processes used in the manufacture of carbon brushes will gladly be shown on request to any organization of engineers or students.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide UCC *and Carbon Corporation*

Carbon Sales Division — SILVER STRAND CABLE TRADE MARK REGISTERED — Cleveland, Ohio

Branch Offices and Factories

New York Pittsburgh Chicago Birmingham San Francisco

POWERFUL
Lifting Magnets
cost no more
When buying lifting magnets, bear in mind that lifting capacities depend largely upon the weight of the principal ingredients—namely the amount of copper and steel furnished in a magnet.
That is why the greater weight of EC&M Lifting Magnets insures more powerful lifts not only for a few operations, but for every operation throughout the day.
Write for a copy of Bulletin 900 which proves that EC&M Lifting Magnets offer you more magnet per dollar invested than ever before.
The Electric Controller and Manufacturing Co.
Cleveland, Ohio

Used by Many Prominent Companies

The Hagan Car Type Furnace shown above is very popular equipment for general heating operations such as annealing steel and grey iron castings, tool steel rods, bars, steel wire and die blocks.

The Allegheny Steel Company, Wyckoff Drawn Steel Company, United Engineering and Foundry Company, The Keystone Driller Company and the American Manganese Steel Company are just a few representative Companies using this type of Hagan Furnace.

This type of furnace equipment is available in several widths and in any length, with hand or motor operated doors—heated with oil, gas or electricity, and supplied with or without car puller as specified.

Let our engineers acquaint you with the many economic advantages of this Hagan Furnace.

GEORGE J. HAGAN COMPANY

Chamber of Commerce Building **Pittsburgh, Penna.**

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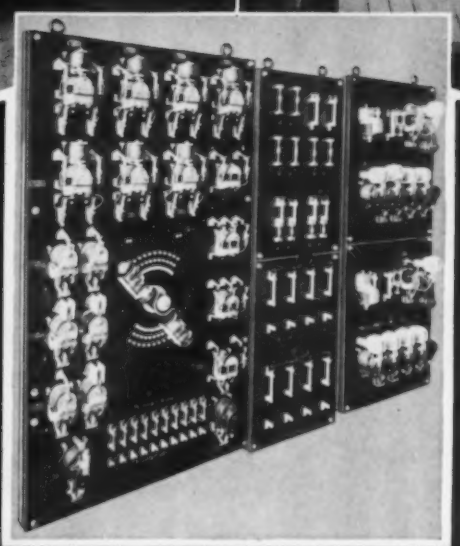
MEETING THE DEMAND!



VARI-TIME CONTROL

BY DIRECT EVIDENCE

THE ABOVE PHOTOGRAPHS TELL OUR STORY.

THIRTY-FOUR CLARK "3 C" VARI-TIME MAGNETIC CONTROLLERS

are shown in various stages of progress through our factory in one day.
They are for many different purposes and for many different customers.

The demand is constantly growing
and
We are growing with the demand.

Write for Bulletin 114.

THE CLARK CONTROLLER CO.

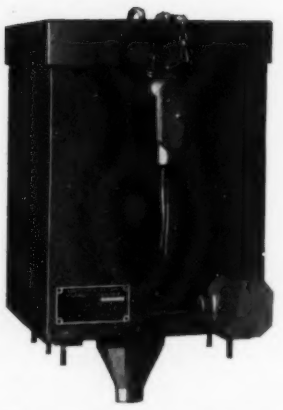
CHICAGO CINCINNATI PHILADELPHIA NEW YORK ST. LOUIS
DETROIT PITTSBURGH **CLEVELAND, O.** KANSAS CITY CANTON, O.

Protect Your Men During Winter Operation

Double No. 80 Lantern.

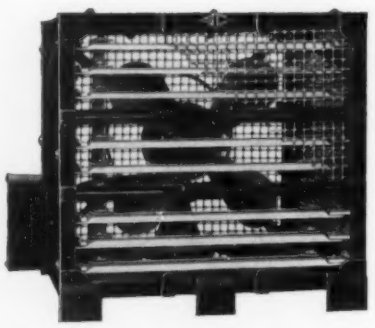
Slippery, ice covered rails make crane operation more hazardous. Spotting is more difficult, strains and misalignments the result. Sand on the rails, when and where needed, is of prime importance.

The Lintern Electro-Magnetic Sander is always on the job. Operated easily, quickly, by a switch mounted in the cab. Sand is kept dry by a Chromalox Heater for positive and quick delivery to the rail. Makes unnecessary the dangerous practice of having a man ride the end carriage with a bucket of sand.



Electro-Magnetic Sander.

N-L



Electric Heater.

The heavy service encountered in winter operation makes crane repairs more frequent. Adequate protection for your men repairing the crane is desirable, and is best provided by the Double No. 80 Lantern. Used in conjunction with a Safety Switch it signals that the crane must not be moved. When the crane is in operation the green light so indicates. This brilliant signal can be seen from all directions.

The N-L Electric Heater gives an abundance of heat, with perfect ventilation an added feature. Constant circulation of fresh heated air keeps your men comfortable, wide awake and on the job at all times. Suitable for crane cabs, yard offices and other isolated spaces.

The Nichols-Lintern Co.

7960 Loraine Avenue CLEVELAND, OHIO

The Economy Engineering Company, Chicago, checks its portable elevators under load with Jewell Masters. Thus tight bearings, dragging brakes and similar trouble makers can be located and adjusted before shipment. Illustration shows test on paper elevator for newspaper plant.

WHY Guess at Motor Loads?

Check them with Jewell Master Instruments

The old proverb, "A stitch in time saves nine," applies to motors as well as to trousers.

Checking motors on machines before shipment,
Checking motors on new installations,
Periodical checking of motors in service,

are all economical insurance against trouble.

Jewell Master Portable Instruments provide a convenient and economical method for all kinds of electrical testing.

Ask the nearest Jewell Representative or mail the coupon.

The Jewell Electrical Instrument Company makes a complete line of high grade A. C. and D. C. instruments for every purpose, including switchboard instruments from 2 inches to 9 inches in diameter, and portable instruments from small pocket sizes to laboratory precision standards. Catalog sent on request.

29 YEARS MAKING GOOD INSTRUMENTS

JEWELL

Master Instruments

Jewell Electrical Instrument Company
1650 Walnut Street, Chicago, Illinois
Of course I want to know about the most complete line of intermediate size instruments. Mail your bulletin.

Name----------

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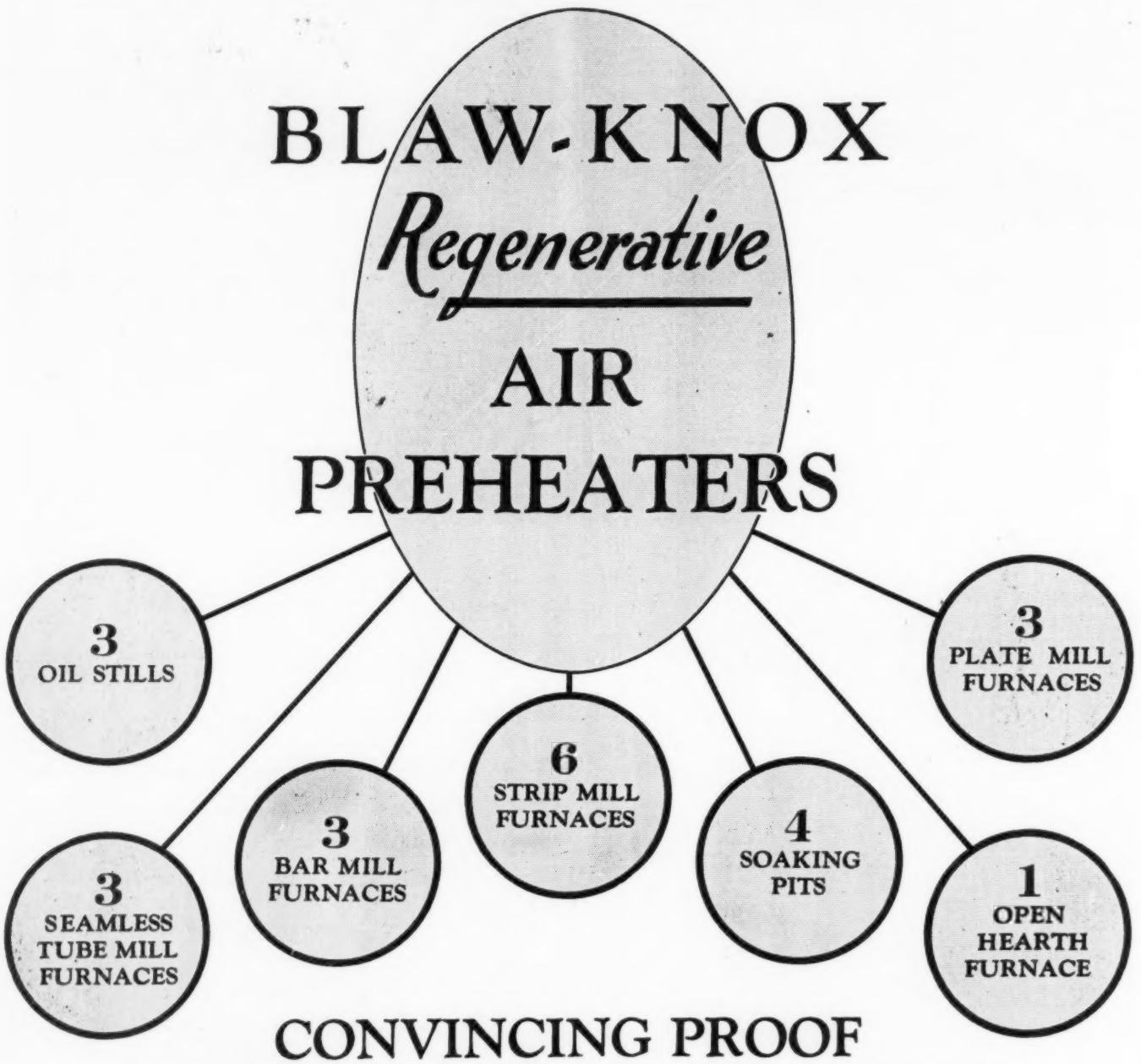
Some Recent Sales of

BLAW-KNOX *Regenerative* AIR PREHEATERS



CONVINCING PROOF

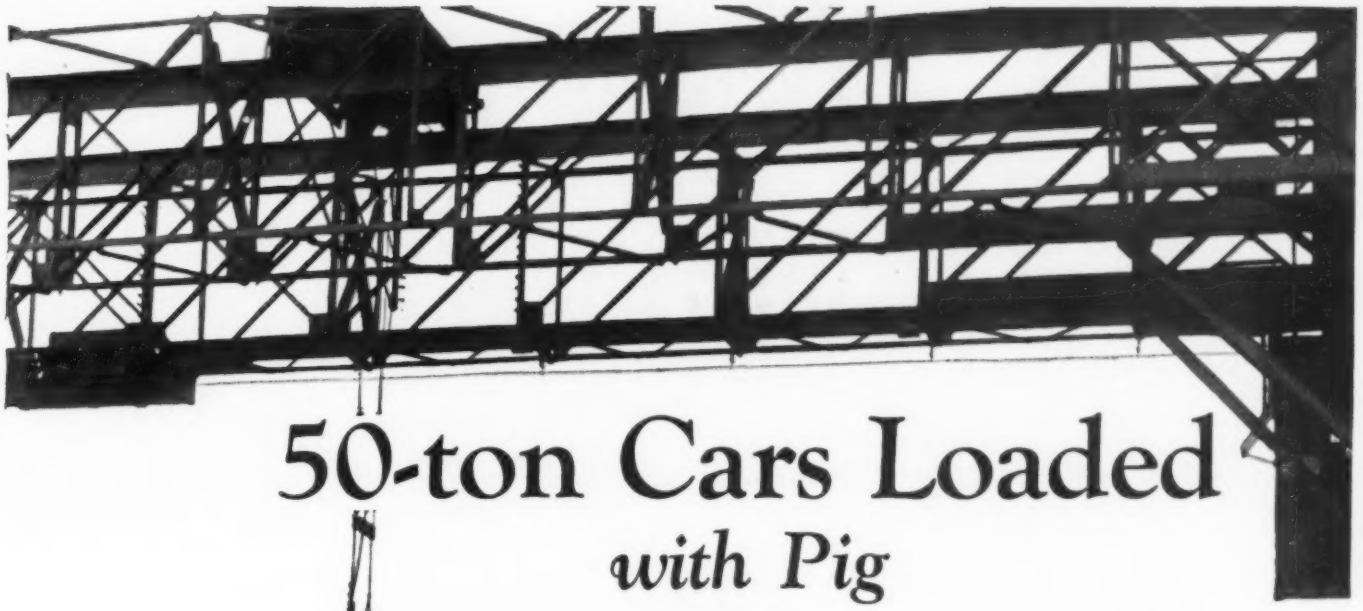
of the wide application of the BLAW-KNOX PREHEATER in the Steel Industry

Ask for Bulletin Number 1072

BLAW-KNOX COMPANY

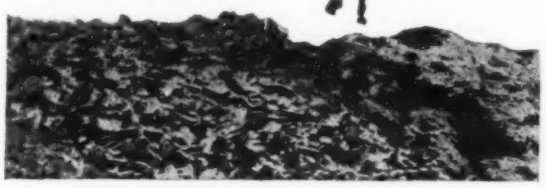
2094 Farmers Bank Bldg., Pittsburgh, Pa.

BLAW-KNOX



50-ton Cars Loaded *with Pig* in 20 Minutes

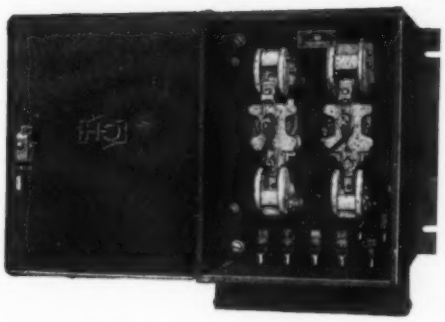
C-H 65" "RedTop" loading pig iron in the plant of the Pittsburgh Metallurgical Co., Niagara Falls, N.Y.



UNUSUAL savings in the handling of metal are possible with Cutler-Hammer "Red Top" Magnets. Often so great that you are reimbursed *yearly* for cost of magnet!

A 65" "Red Top" serves the Pittsburgh Metallurgical Company at Niagara Falls . . . handles steel turnings and pig iron. This "Red Top" loads a 50-ton car with pig in 20 minutes. Hardly any force of men mustered for the work could duplicate such speed.

C-H *pioneer* design—the standard in the field—assures long-life service. Shoulder on outer shoes protects coil from shock. Steel spool has always given added lifting power. Vacuum-pressure impregnated coils provide absolute moisture-proof construction. Close fitting parts assure maximum radiation of heat. And in addition absolute safety to operator and mechanism is assured by the C-H enclosed control panel.



Safety for both operator and mechanism

The C-H magnet control panel is completely enclosed—protecting the operator and shielding the mechanism from blows, dirt, and the weather. For further safety, the master switch handles only a pilot circuit, so that neither the lifting current nor the discharge voltage can reach the operator.

The C-H Controller is supplied with all "Red Tops" but can be used with any make of Magnet.

This interesting profit story is dealt with in detail in the booklet "Modern Metal Handling Methods". Send for a copy.

CUTLER-HAMMER, Inc.
Pioneer Manufacturers of Electric Control Apparatus
1257 St. Paul Avenue
MILWAUKEE, WISCONSIN

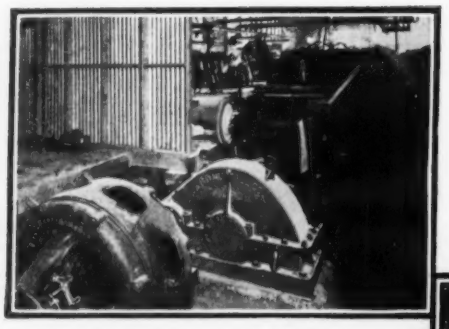
CUTLER HAMMER

C-H

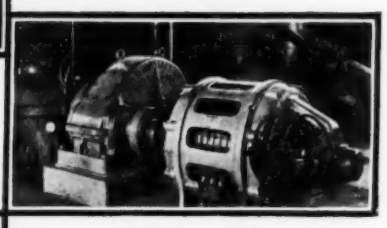
Red Top Heavy Duty Lifting Magnets

(8718)

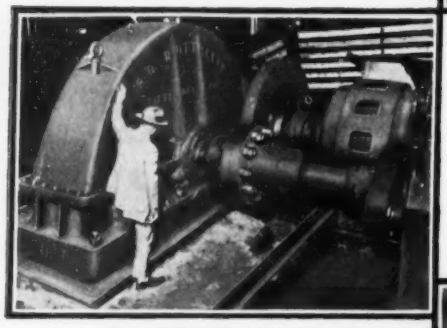
Where Westinghouse-Nuttall Mill Drives *are going* - -



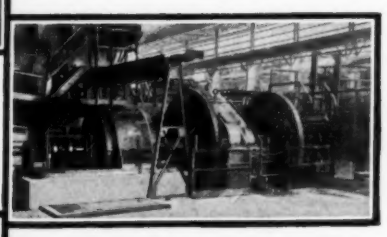
200-hp. Unit on Wire Drawing Machine Drive.



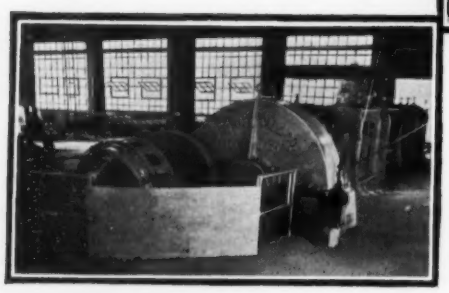
400-hp. Unit on Centrifugal Water Pump Drive.



350-hp. Unit on Piercing Mill Drive.



1000-hp. Unit on Tube Mill Drive.



400-hp. Unit on Rod Mill Drive.

THE accompanying illustrations typify the diversity of heavy-duty service in which Westinghouse-Nuttall single-reduction mill units are now being used

Forty years' experience in the design and manufacture of successful gear drives for industrial purposes is the assurance of continuous, dependable and economical performance wherever these sturdy mill units are installed.

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NUTTALL WORKS PITTSBURGH, PA.
SALES OFFICES IN ALL PRINCIPAL CITIES OF THE UNITED STATES AND FOREIGN COUNTRIES
CANADIAN AGENTS: LYMAN TUBE & SUPPLY CO.

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Switchboards
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WATCH the number of users mount up in next month's issue of Iron and Steel Engineer.

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The Martindale Electric Company

CLEVELAND, OHIO

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Send me complete information and prices on Martindale Commutator Stones.

Name and Title.....

Company.....

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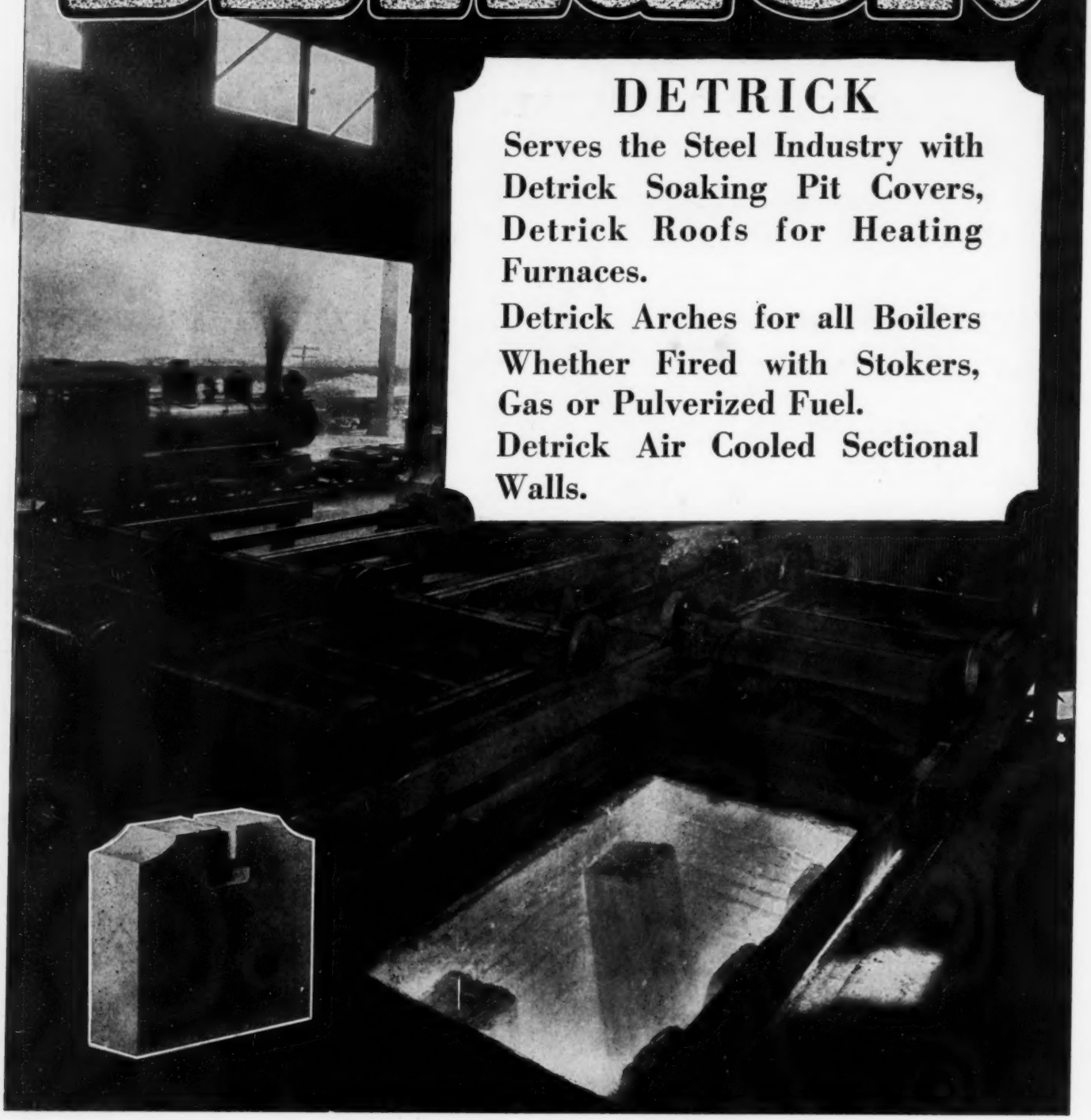
City..... State.....

12/29

DETRICK



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Serves the Steel Industry with Detrick Soaking Pit Covers, Detrick Roofs for Heating Furnaces.

Detrick Arches for all Boilers Whether Fired with Stokers, Gas or Pulverized Fuel.

Detrick Air Cooled Sectional Walls.

M. H. DETRICK COMPANY

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